National Park Service
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Natural Resource Program Center

Invasive Plant Species Early Detection in the San Francisco Bay Area Network

2008 Annual Report

Natural Resource Report NPS/SFAN/NRTR—2010/308

ON THE COVER
Golden Gate Weed Watcher Volunteers Caorlyne Orazi, Lou Sian, and Debbie Blancas Conduct Survey of Sweeney Ridge
Photograph by: Jen Jordan, NPS

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Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols. This report received formal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data, and whose background and expertise put them on par technically and scientifically with the authors of the information.

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Executive Summary

In 2000, the National Park Service (NPS) created 32 networks of NPS units across the United States that were formed and funded to "improve the ability of the NPS to provide state-of-the-art management, protection, and interpretation of and research on the resources on the NPS … and to assure the full and proper utilization of the results of scientific studies for park management decisions" (NPS 1998). The San Francisco Bay Area Network (SFAN) is one of eight of these networks in the Pacific West Region of the NPS.

SFAN is composed of eight park units and includes Point Reyes National Seashore (PORE), Pinnacles National Monument (PINN), John Muir National Historic Site (JOMU), Eugene O'Neill National Historic Site (EUON), and Golden Gate National Recreation Area (GOGA) including Muir Woods National Monument and Fort Point National Historic Site. The network fosters collaboration and creates efficiencies of scale in designing and implementing a natural resource focused Inventory and Monitoring (I&M) program.

The network has identified vital signs, indicators of ecosystem health, which represent a broad suite of ecological phenomena operating across multiple temporal and spatial scales. Our intent has been to monitor a balanced and integrated "package" of vital signs that meets the needs of current park management, but will also be able to accommodate unanticipated environmental conditions in the future. Invasive plants represent a particularly high priority vital sign for SFAN because of the negative effects they have on the park resources, including altering landscapes and fire regimes, reducing native plant and animal habitat, and blocking views and increasing trail maintenance needs.

Parks need to know where incipient populations of highly invasive plants are becoming established, and protect the most critical areas from invasion. This year was the second full field season of testing the early detection protocol. The methods detailed in this report focus on surveying road- and trail-side in priority areas using volunteers, and is based on the SFAN I&M Network's Early Detection Monitoring of Invasive Plant Species in the San Francisco Bay Area Network: A Volunteer-Based Approach (Williams et al. 2009).

The Golden Gate National Recreation Area contains 38 subwatersheds deemed at high risk of invasion and/or harm to significant biological resources, of which 33 subwatershed were within the boundaries actively managed by the park. Searches were conducted by teams of two or three along the prioritized trails and roads in these subwatersheds looking for up to 73 plant species ranked as having the greatest risk for invasion in these areas. One thousand and seventy-six high-priority plant populations were mapped in the park. The most common highest priority (List 1) species that were found were capeweed (*Arctotheca calendula*), tocalote (*Centaurea melitensis*), Scotch broom (*Cytisus scoparius*), and licorice plant (*Helichyrsum petiolare*). Of 80 subwatersheds searched in 2008, 45 were found to contain the highest priority species. Eighteen of these 45 subwatersheds were deemed at high risk for invasion.

The Point Reyes National Seashore contains 78 subwatersheds total. Of these, 20 subwatersheds are determined to be at high risk of invasion and/or harm to significant biological resources. Eighteen of these high-priority subwatersheds were located within the boundaries actively

managed by the park. There are also 20 significant-priority, 19 moderate-priority and 19 low-priority subwatersheds. Searches were conducted as in GOGA, but for an even larger list of 92 plant species ranked as having the greatest risk for invasion in these areas. Two hundred and seventy-four high-priority plant populations were mapped in the park. The most commonly found List 1 species were woolly distaff thistle (*Carthamus lanatus*), orange cotoneaster (*Cotoneaster franchetii*), and silverleaf cotoneaster (*Cotoneaster pannosus*). Of 33 subwatersheds searched, 12 were found to contain the highest priority species, four of which were deemed at high risk for invasion.

Maps were created of all areas surveyed in GOGA, PORE, and PINN as well as for priority plant species found. Based on the results, the species lists were modified to better reflect actual population levels within the park.

Volunteers played an important role in the implementation of the field surveys at both GOGA and PORE. At GOGA, 15 volunteers assisted staff to conduct surveys, contributing 1023 hours, worth $18,454.92. At PORE, three volunteers over three months were trained on a one-on-one basis to conduct surveys. These volunteers contributed 23 hours of their time, worth $956.12. At PINN, one volunteer contributed four hours.

Web pages were enhanced to educate the public about the project and provide support to existing volunteers. Additions to the web pages include survey maps, species lists and data sheets. Collaborative efforts with staff at PORE, GOGA, and the Golden Gate National Parks Conservancy were continued to facilitate communication of findings and to broaden the early detection network.

Acknowledgements

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1.0 Introduction

1.1 Background

Invasive plant species negatively affect park resources and visitor enjoyment in several ways, including altering landscapes and fire regimes, reducing native plant and animal habitat, and blocking views and increasing trail maintenance needs. Invasive species are second only to habitat loss as threats to global biodiversity (e.g., Scott and Wilcove 1998). Given the extraordinary biodiversity of the San Francisco Bay Area, and the development pressure on private lands in the area, SFAN parks serve as crucial refugia for native species. Over 100 rare plant species can be found in SFAN parks. Invasive plants threaten many of these rare species: in Golden Gate National Recreation Area (GOGA) alone, 25 species of non-native plants were noted as directly threatening rare plant populations (GOGA 2004). Trails, roads and waterways are the main routes of infestation in most natural areas, and the SFAN is no exception. Monitoring the likely routes of invasion and uninfested areas is the most effective way to prevent the spread of existing species and the infestation of new species in SFAN parks (McNeely et al. 2001).

Inventory and Monitoring staff ranked both species and areas to prioritize search efforts for early detection (Williams et al. 2009, in review). The management areas are divided based on geographical features; GOGA into 29 watersheds and 149 subwatersheds (smaller subunits of watersheds based largely on drainages), and PORE into 7 watersheds and 78 subwatersheds. These subwatersheds were prioritized based on a ranking matrix containing information from three general areas: management priority for protection of rare plants and/or animals; risk of invasion due to infrastructure or habitat vulnerability; and current level of infestation. This ranking process assigned each subwatershed in the park with a high, significant, moderate, or low priority for survey (see Appendix A).

The GOGA and PORE exotic plant lists, which both number over 300 species, were also ranked to prioritize search efforts. All species were first ranked based on their status on existing lists of known invasives (California Invasive Plant Council, The Nature Conservancy, and California Food and Agriculture), and on any published literature or expert opinion which documents the plants as an ecosystem alterer or rare plant endangerer. All plants which were found to have documented invasive characteristics based on this ranking were then categorized based on biological ease of control independent of acres already infested, and feasibility of control based on existing infestation acreage and cost for removal. This process resulted in a SFAN Invasive species list of 174 plant species for GOGA and 141 species for PORE. After full survey seasons, these lists have been refined to better reflect early detection priorities for each park (see Appendix B). List 1 and 3.1 species are highly invasive but not widespread; List 2 and 3.2 species are highly invasive but more widespread, or moderately invasive and not widespread; List 3 species are highly invasive and widespread; List 4 species are of low to moderate invasiveness. These lists will be revised each year after results from the survey season have been reviewed.

Looking for the worst plants in the best places

Parks need to know where incipient populations of highly invasive plants are becoming established, and protect the most critical areas from invasion. Budget constraints necessitate looking in areas where it will do the most good—in high-quality and high-risk areas—along a primary vector for invasive plants, using volunteer labor. While surveyors may readily spot some species of weeds far from the trail in the open scrub and grasslands of SFAN parks, it is difficult to determine with high confidence where plants do not occur, particularly with species that are inconspicuous or senescent during a portion of the year or low in stature, more than a few meters from roads and trails. However, absence directly adjacent to survey corridors is still valuable to park managers as these are the most likely sites for incipient populations to become established in a park.

1.2 Objectives

Objectives for the 2008 field season were based on those from the main protocol.

1. Within GOGA and PORE, identify and inventory all roads and trails in high-priority subwatersheds, and half the significant-priority subwatersheds, noting presence and absence of priority weed species. Use visual assessment and GPS technology to detect and accurately map incipient populations of the top-priority plant species on the GOGA and PORE Invasive Plant lists.

2. Train volunteers to conduct early detection surveys for top-priority SFAN Invasive Plants in the high-priority areas.

3. Train GOGA and PORE staff and park-partner staff to identify top-priority SFAN Invasive Plants for opportunistic early detection of new populations during regular work activities.

4. Revise priority species list based on information acquired during the 2008 field season.

5. Develop priorty species list for PINN and survey select trail and stream corridors using this list.

2.0 Methods

All methodology is based on the SFAN I&M Network's Early Detection Monitoring of Invasive Plant Species in the San Francisco Bay Area Network: A Volunteer-Based Approach (Williams et al. 2009). This program can be adapted to different person-hours and skill levels, allowing parks to maximize their effectiveness based on resources available. Engaging people in detection; giving them clear direction and a point person to answer questions and receive invasives reports; and following up with feedback on reports are essential components to a good program. The following section describes sampling methods, scheduling, data management and data collection.

2.1 Prioritization

Full prioritization methods can be found in the protocol, but are summarized briefly here.

2.1.1 Species

The lists of target species for GOGA, PORE, and PINN were based on current knowledge and rankings, summing recognized invasiveness and biological ease of control and stratifying into priorities by feasibility of control based on categories of actual or estimated species' infested acreage in the park. A list of all exotic species known or thought to occur in both parks (~300 species in each park), compiled from NPSpecies, was the base list. After removing known non-invasive species, and species locally non-native, 174 species remained for GOGA and 141 remained for PORE. Species listed by the California Invasive Plant Council (Cal-IPC), California Department of Food and Agriculture (CDFA), The Nature Conservancy (TNC), and local Weed Management Areas received varying numbers of points for invasiveness, as did unlisted species which shared invasive characteristics with a listed congener. Based on best available knowledge, species also received points for altering ecosystems—affecting a system change, not just crowding out other plants—and for endangering rare plants in SFAN parks. Next, based on best available knowledge, species were ranked by ease of control independent of number of acres infested. All points were summed for the overall invasiveness score, then sorted according to feasibility of control based on number of acres infested with that species, cost for removal, politics, and access. Species shown to be highly invasive, but not widespread in the park, were top priority for detailed mapping; more widespread but still invasive species were mapped with a point unless populations are small.

2.1.2 Areas

The list of priority areas for searches was made by ranking subwatersheds—drainage-based subunits of watersheds—by number and degree of current infestations; risk of further infestation; and priority of resources present. Higher scores were received for low current infestation levels, high risk of further infestation based on presence of infrastructure or invadable vegetation type, and presence of rare plants or animals. Subwatersheds were ranked, grouped along the most natural breaks, and assigned a score. Total score was obtained by adding risk to weighted (2x) rare species priority score and subwatersheds approximately quartered into high, significant, moderate, and low priority. High-priority subwatersheds are visited annually; significant and moderate, biennially; and low, once every five years.

2.2 Search Areas

GOGA is divided into 29 watersheds and 149 subwatersheds, based on topography (see maps, Appendix A). Thirty-eight of these subwatersheds were deemed at high risk of invasion and/or harm to significant biological resources, of which 33 subwatersheds were within the boundaries actively managed by the park. Within these 33 subwatersheds are 69 miles of trails and roads officially mapped by GOGA staff. These roads and trails within the high-priority areas of the park were the first areas to be searched.

PORE is divided into 78 subwatersheds (see maps, Appendix A). Twenty of these subwatersheds were deemed at high risk of invasion and/or harm to significant biological resources, of which 18 were within the boundaries actively managed by the park. Within these 18 subwatersheds are about 45 miles of trails and roads officially mapped by the PORE staff.

Twenty-two of the 149 GOGA subwatersheds actually fall under the management of PORE. The early detection program at PORE was responsible for the surveys of these subwatersheds, only six of which were scheduled to be surveyed in 2008. These areas were surveyed using the PORE species lists and all data related to them can be found with PORE results.

Maps have been made for the areas that need revisits and continued stewardship, and can be found online at http://science.nature.nps.gov/im/units/sfan/vital_signs/Invasives/maps.cfm and on park servers: at GOGA, on the inpgogamahe1:\Divisions\Network I&M\Shared\Vegetation\Invasive Plants\spatial_information\EDsitemaps\2008edmaps\Mapbooks; and at PORE on inppore05:\Natural_Vegetation\Veg restoration team\Early detection\GIS\Finished Survey Maps. These maps are available for staff and the volunteer stewards who will adopt an area to patrol for new invasions.

2.3 Field Methods

Searches were conducted by teams of one to four individuals along the 69 miles (GOGA) and 45 miles (PORE) of trails and roads in the high-priority areas of the park. Teams usually covered no more than two to five miles of the project area per team per day, depending on target invasive plant densities, vegetation, and terrain. Each survey route was recorded both on a paper map of the area and digitized from a tracklog into a polyline layer using ESRI's ArcPad or ArcMap program. Though survey areas were only limited by the visual range of the surveyor, the official search area used for logging both positive (plant occurrence) and negative data (areas where target plants were not found) was restricted to a few meters on either side of the route. Surveys for PINN were conducted during a one week visit using the same methods as PORE and GOGA; however, stream corridors were surveyed in addition to roads and trails.

Along the survey route observers recorded location and associated biological information (phenology, habitat, distribution) for all high-priority target plant populations encountered. Depending on their level of training, GOGA surveyors walked the routes looking for either the 12 highest-ranked target plant species (List 1 plants), the 25 highest-ranking plants (List 1 and 2 plants), or the 73 highest-ranking plants (List 1, 2, 3.1, 3.2, and 3 plants). At PORE, surveyors searched for either the 13 highest-ranked target plant species (List 1 plants), the 42 highest-ranking plants (List 1, and 2 plants), or the 92 highest-ranking plants (List 1, 2, 3.1, and 3 plants)

The level of detail of data collection was dictated by the ranking of the plant on the priority list, and the extent of the infestation. This tiered approach to data collection reduces the time needed to collect standardized, detailed data in areas of high infestations as well as the amount of training needed for beginner surveyors (Figure 1).

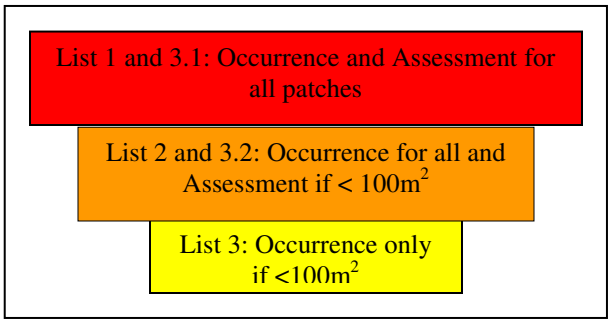

Figure 1. Tiered levels of data collection.

For the initial survey of a route, point *occurrences* and polygon *assessments* were mapped for List 1 and 3.1 species; point *occurrences* and polygon *assessments* (if patch size is less than 100 m^2) for List 2 and 3.2 species; presence/absence, or point *occurrences* (if patch size is less than 100 m^2) for List 3 species; presence/absence recorded for lower-priority species, along with the *survey area*. For subsequent surveys most *occurrences* should already exist.

All data was collected on paper data sheets and then entered into the GOGA, PINN or PORE GeoWeed database and/or was captured in the field using hand-held GPS/PDA units installed with ESRI's Arc Pad software with the GeoWeed tool bar and then downloaded into the GeoWeed database. Downloaded and entered data were checked against field data sheets for correctness and completeness. Staff and long-term interns performed downloading and data-checking tasks.

Every mapping session (day/team) also include a new *survey area* to record absence data for species not seen, and may include an inventory of all species seen if the observer is sufficiently advanced. Assessments also include ancillary data on habitat, phenology and distribution. Species identifications for occurrences and surveys have an associated confidence level to flag potential misidentifications.

A detailed description of all field methodology can also be found the Early Detection of Invasive Plants SOP 2: Mapping and SOP 3: Field Data Collection (Williams et al. 2009, in review).

2.4 Trainings

A key element of the Weed Watcher program is engaging a maximum number of searchers in opportunistic sampling, both in incidental or passive searches, as well as directed active searching. Participants must be trained to identify target species, then to communicate location, distribution, and biological attributes to the correct entities to ensure timely response. To this end, several types of trainings were held including weed identification, invasive plant mapping, and GeoWeed database trainings. Each of these courses catered to training participants to gather increasingly detailed levels of data about weed infestations.

The "WeedID" class defined the invasive species concept, how invasive species are moved around the park and how natural resources are affected, target invasive plant identification, and how to report target plant sighting. The class was conducted through two hours of classroom

instruction and one hour of field instruction. Classroom instruction relied on PowerPoint presentations, "Plant-out-of-Place" identification cards, and specimens of target species whenever possible. Power Point presentations can be found at inpgogamahe1:\Divisions\Network I&M\Shared\Vegetation\Invasive Plants\weedwatchers \training\plantid_train. The "Plant-out-of-Place" cards can be found at: inpgogamahe1:\Divisions\Network I&M\Shared\Vegetation\Invasive Plants\Species\ID cards or online at http://science.nature.nps.gov/im/units/sfan/vital_signs/Invasives/ID_cards.cfm.

The invasive plant mapping course is a three-to four-hour introduction to GOGA protocols for data collection, minimum data elements needed when mapping plants, aerial and topographic map interpretation, how to mark infestations on a map, how to calibrate distance and cover estimations, introductory GPS and ESRI Arc Pad methods. This course is designed to be conducted half in classroom and half with hands-on activities outside. An optional introduction to the ArcPad GeoWeed applet can be included in an afternoon session. The PowerPoint presentation can be found at inpgogamahe1:\Divisions\Network I&M\Shared\Vegetation \Invasive Plants\weedwatchers\training\plantid_train.

Additionally, a GeoWeed database training was held to introduce data managers at GOGA to the new invasive plant data management system. The GeoWeed data management system was used to record all of the Weed Watcher data, as well as act as a conduit for this information to be transmitted to all invasive plant managers in the parks. As such, it is integral to the project's success to train as many individuals as possible at the parks to effectively use this database. The all-day training covered the database schema, form navigation, data entry, an introduction to the GeoWeed Arc Pad applet, and GPS trouble-shooting.

2.5 Analyses/GIS Manipulations

Data from GeoWeed were examined for patterns in occurrences by species type and location. Using the "filter" function, the number of occurrences for a species; total acreage for List 1 species; number of subwatersheds in which a species occurred; number of search hours and observers were also extracted. Shapefile attribute tables were examined for number of invasive species occurrences by list and subwatershed priority.

2.6 Species List Revisions

This year represented the first full field season of data collection in PORE and second full field season in GOGA, and the opportunity to revise the priority lists based on better quantitative information for how widespread species are in the parks. The number of occurrences, and number of subwatersheds in which species were found, were examined and compared to listing level for appropriateness. Species found in more than 15 subwatersheds—10% of all park subwatersheds—were deemed too widespread for List 1, and species with over 50 occurrences were moved to List 3. List 1 species with no occurrences were thought too rare to be reliably identified by volunteers, and were moved to List 3.1: this list is for advanced observers, such as trained staff and botanists, but species are treated as List 1 for data collection purposes.

3.0 Results

The number of miles of trails and subwatersheds covered; the number of persons trained and actively detecting, and hours spent searching; and the number of species of each priority type in each priority level subwatershed are presented below. Maps from surveys may be found online at: http://science.nature.nps.gov/im/units/sfan/vital_signs/Invasives/report_maps.cfm.

3.1 GOGA

3.1.1 Search Effort

Eighty-three miles were surveyed within GOGA during the 2008 field season. In total, 18 people spent just under 1,400 hours to complete these surveys; 1,023 of these hours were volunteer hours. Fifteen volunteers assisted staff to conduct surveys, contributing 1023 hours. Included in this 15 were three interns for two months, who mainly worked in GOGA but also helped on a few PORE surveys.

Eighty subwatersheds total were surveyed in 2008. This included all 65 Priority subwatersheds that were scheduled to be surveyed in 2008 as well as 15 lower-priority subwatersheds that were generally surveyed on the route to or from a high-priority subwatershed.

3.1.2 Species Detected

Fourty five of the 80 subwatersheds surveyed contained List 1 species (Tables 1 and 2). Eighteen of these subwatersheds were high-priority subwatersheds, 13 were significant-priority subwatersheds, eight were moderate-priority subwatersheds, five were low priority, and one was within GOGA legislative boundaries, but not within the management boundaries of the park. Fifty-three of the 80 subwatersheds were found to contain List 2 target species. Twenty-five of these subwatersheds were high-priority areas, 13 were significant-priority subwatersheds, eight were moderate-priority areas, six were low-priority areas, and one was within GOGA legislative boundaries, but not within the management boundaries of the park. Fifteen subwatersheds were found to contain List 3.1 target species. Six of these subwatersheds were high-priority areas, two were significant-priority subwatersheds, four were moderate-priority areas, and three were low-priority areas. Twenty-three subwatersheds were found to contain List 3.2 target species. Ten of these subwatersheds were high-priority areas, seven were significant-priority subwatersheds, three were moderate-priority areas, and three were low-priority areas.

One thousand and ninety-nine individual occurrences of target weed species were mapped in GOGA and entered into the GOGA GeoWeed database. One thousand and seventy-six of these occurrences were List 1, 2, 3.1, 3.2, or 3 species (Table 2). Two hundred of these occurrences were List 1 species, 350 were List 2 species, 31 were List 3.1 species, 68 were List 3.2 species and 427 of these occurrences were List 3 species.

In GOGA, 68 species were mapped during the surveys. All of the 13 List 1 and 13 List 2 species were found, as well as five List 3.1 species, seven List 3.2 species and 14 List 3 species. One List 2 species had zero mapped occurrences, but was recorded on a species list as being found in survey areas with a very low confidence level in identification. No List 5.1 species were found

because there were no aquatic surveys. The most commonly found List 1 species were Capeweed, Scotch broom, tocalote, and licorice plant.

Table 1. Number of invasive species and number of subwatersheds with invasives species found at GOGA in 2008.

Measure	Result
Number of List 1 and 2 priority invasive species detections	List 1: 13 of 13 species List 2: 13 of 13 species
Number of subwatersheds with invasive species	List 1: 45 of 80 subwatersheds consisting of: 18 High Prioirty subwatersheds 13 Significant Priority 8 Moderate Priorty 5 Low Priority 1 not within management boundaries List 2: 53 of 80 subwatersheds consisting of: 25 High Prioirty subwatersheds 13 Significant Priority 8 Moderate Priorty 6 Low Priority 1 not within management boundaries

3.2 PORE

3.2.1 Search Effort

Fifty-four miles were surveyed during the 2008 field season at PORE, two of which were on GOGA property managed by PORE. In total, seven people spent 175 hours to complete these surveys. Three volunteers over three months were trained on a one-on-one basis to conduct surveys. These volunteers contributed 23 hours of their time.

During the 2008 field season at PORE a total of thirty-three (27 subwatershed belonging to PORE and six that belong to GOGA but are manged by PORE) subwatersheds were partially to entirely surveyed. Twelve of the 33 subwatersheds were found to contain List 1 species (8 PORE subwatersheds and 4 GOGA subwatersheds; Tables 3 and 4). Four (all PORE) of these subwatersheds were high priority subwatersheds, two (PORE) were significant priority subwatersheds, three (all GOGA) were moderate priority subwatersheds, and three (2 PORE, 1 GOGA) were low priority. Twenty-nine of the 33 subwatersheds were found to contain List 2 target species (23 PORE, and 6 GOGA). Nine of these subwatersheds (all PORE) were high priority subwatersheds, Eight (6 PORE; 2 GOGA) were significant priority subwatersheds, seven (4 PORE; 3 GOGA) were moderate priority subwatersheds, and five (4 PORE; 1 GOGA) were low priority subwatersheds. Three subwatersheds were found to contain List 3.1 target species. One of these subwatersheds was a PORE high-priority area, one was a PORE significant-priority subwatershed, and one was a PORE low-priority area.

3.2.2 Species Found

Two hundred and seventy eight occurrences of target weed species were mapped in PORE and entered into the PORE GeoWeed database in 2008. Two hundred and seventy-four of these occurrences were List 1, 2, 3.1, 5.2 or 3 species. Twenty-four of these occurrences were List 1 species, 149 were List 2 species, seven were List 3.1 species, 13 were List 5.2, and 81 were List

3 species. The most commonly found List 1 species were woolly distaff thistle, orange cotoneaster, and silverleaf cotoneaster.

Forty-one species were mapped during the 2008 PORE surveys. Four of the 13 List 1 species were found, 20 out of 29 List 2 species, one out of eight List 3.1 species, both List 5.2 and 14 of the 44 List 3. No List 5.1 species were found because there were no aquatic surveys. There was one directed survey for dune plants that resulted in the two List 5.2 plants mapped in PORE.

Table 2. GOGA Occurrences and subwatersheds based on 2006-2008 field results. 2008 percentages based on 80 subwatersheds searched.

08 List	Scientific Name	Common Name	Number of occurences	Number of subwatersheds	Percent subwatersheds with species
1	*Arctotheca calendula*	capeweed	30	12	15.0%
1	*Centaurea calcitrapa*	purple starthistle	3	3	3.8%
1	*Centaurea melitensis*	tocalote	45	14	17.5%
1	*Cortaderia selloana*	Uruguayan pampas grass	3	3	3.8%
1	*Cytisus scoparius*	Scotch broom	29	15	18.8%
1	*Cytisus striatus*	Portugese broom, striated broom	19	8	10.0%
1	*Digitalis purpurea*	purple foxglove	5	3	3.8%
1	*Euphorbia oblongata*	Eggleaf or oblong spurge	2	2	2.5%
1	*Helichrysum petiolare*	licorice plant	57	16	20.0%
1	*Ilex aquifolium*	English holly	5	3	3.8%
1	*Ulex europaea*	Gorse, furze	3	1	1.3%
1	*Vinca major*	periwinkle	14	7	8.8%
2	*Acacia melanoxylon*	blackwood acacia	42	16	20.0%
2	*Ageratina adenophora*	thoroughwort, crofton weed	55	15	18.8%
2	*Conium maculatum*	poison hemlock	40	17	21.3%
2	*Delairea odorata*	cape ivy	40	17	21.3%
2	*Dipsacus fullonum*	common teasel, Fuller's teasel	18	4	5.0%
2	*Eucalyptus globulus*	bluegum eucalyptus	16	11	13.8%
2	*Hedera helix*	English ivy	30	18	22.5%
2	*Hirschfeldia incana*	shortpod mustard			0.0%
2	*Holcus lanatus*	velvet grass, Yorkshire fog	36	18	22.5%
2	*Leucanthemum vulgare*	ox-eye daisy	28	13	16.3%
2	*Mentha pulegium*	pennyroyal	24	14	17.5%
2	*Oxalis pes-caprae*	Bermuda buttercup	6	4	5.0%
2	*Rubus discolor [procerus, armeniacus]*	Himalayan blackberry	54	20	25.0%
3	*Brasica rapa*	field mustard	2	1	1.3%
3	*Briza maxima*	big quakinggrass	7	6	7.5%
3	*Carpobrotus edulis*	hottentot fig, freeway iceplant	14	7	8.8%
3	*Cortaderia jubata*	jubata grass	71	32	40.0%
3	*Cotoneaster franchetii*	orange cotoneaster	39	12	15.0%
3	*Cotoneaster pannosus*	silverleaf cotoneaster	36	20	25.0%
3	*Ehrharta erecta*	panic veldt grass	91	14	17.5%
3	*Erechtites glomerata*	Australian fireweed, cutleaf burnweed	20	9	11.3%
3	*Erechtites minima*	Australian fireweed, coastal burnweed	12	3	3.8%
3	*Foeniculum vulgare*	sweet fennel	21	13	16.3%
3	*Genista monspessulana*	French broom	133	39	48.8%
3	*Phalaris aquatica*	harding grass	28	16	20.0%
3	*Pinus radiate*	Monterey pine	19	14	17.5%
3	*Rumex acetosella*	sheep sorrel	0	0	0.0%
3	*Schinus molle*	pepper tree	1	1	1.3%
3	*Tamarix chinesis*	saltcedar	0	0	0.0%
3	*Xanthium spinosum*	spiny cockleburr	0	0	0.0%
3	*Xanthium strumarium*	rough cockleburr	0	0	0.0%
3.1	*Alianthus altissima*	tree-of-heaven	0	0	0.0%
3.1	*Albizia lophantha*	silk tree	0	0	0.0%
3.1	*Berberis darwinii*	Darwin's berberis	0	0	0.0%

Table 2. GOGA Occurrences and subwatersheds based on 2006-2008 field results. 2008 percentages based on 80 subwatersheds searched (continued).

08 List	Scientific Name	Common Name	Number of occurences	Number of subwatersheds	Percent subwatersheds with species
3.1	*Brachypodium distachyon*	purple false brome	0	0	0.0%
3.1	*Carduus acanthiodes*	plumeless thistle	0	0	0.0%
3.1	*Carthamus lanatus*	woolly distaff thistle	0	0	0.0%
3.1	*Centaurea solstitialis*	yellow starthistle	0	0	0.0%
3.1	*Cirsium arvense*	Canada thistle	0	0	0.0%
3.1	*Crataegus monogyna*	singleseed hawthorn	13	10	12.5%
3.1	*Cynara cardunculus*	artichoke thistle	0	0	0.0%
3.1	*Cynodon dactylon*	Bermudagrass	2	2	2.5%
3.1	*Dittrichia graveolens*	stinkweed	0	0	0.0%
3.1	*Echium plantagineum*	salvation jane	0	0	0.0%
3.1	*Ehrharta calycina*	perennial veldt grass	0	0	0.0%
3.1	*Hedera canariensis*	Algerian ivy	0	0	0.0%
3.1	*Hypericum perforatum*	Klamathweed	0	0	0.0%
3.1	*Nicotina glauca*	tree tobacco	0	0	0.0%
3.1	*Phalaris arundinacea*	reed canary grass	0	0	0.0%
3.1	*Pittosporum crassifolium*	stiflear cheesewood	0	0	0.0%
3.1	*Robinia pseudoacacia*	black locust	0	0	0.0%
3.2	*Bromus diandrus*	ripgut brome	28	17	21.3%
3.2	*Bromus madritensis ssp. Rubens*	red brome	6	4	5.0%
3.2	*Bromus tectorum*	cheat grass, downy brome	0	0	0.0%
3.2	*Dactylis glomerata*	orchard grass, cocksfoot	5	4	5.0%
3.2	*Festuca arundinacea*	tall fescue	14	10	12.5%
3.2	*Leptospermum laevigatum*	Australian teatree	8	6	7.5%
3.2	*Pennisetum clandestinum*	Kikuyu grass	5	4	2.5%
3.2	*Rose eglanteria*	sweetbriar rose	3	2	2.5%

Table 3. Number of invasive species and number of subwatersheds with invasives species found at PORE in 2008.

Measure	Result
Number of List 1 and 2 priority invasive species detections	List 1: 4 of 13 species List 2: 20 of 29 species
Number of subwatersheds surveyed with invasive species	List 1: 12 of 33 subwatersheds consisting of: 4 High Prioirty subwatersheds 2 Significant Priority 3 Moderate Priorty 3 Low Priority List 2: 29 of 33 subwatersheds consisting of: 9 High Prioirty subwatersheds 8 Significant Priority 7 Moderate Priorty 5 Low Priority

Table 4. PORE Occurrences and subwatersheds based on 2008 field results. Percentages based on 33 subwatersheds searched.

2008 List	Scientific Name	Common Name	Number of occurences	Number of subwatersheds	Percent subwatersheds with species
1	*Carduus acanthoides*	plumeless thistle	0	0	0.0%
1	*Carthamus lanatus*	woolly distaff thistle	10	6	18.2%
1	*Centaurea calcitrapa*	purple starthistle	0	0	0.0%
1	*Centaurea iberica*	Iberian starthistle	0	0	0.0%
1	*Centaurea melitensis*	Napa thistle, tocalote	1	1	3.0%
1	*Centaurea solstitialis*	yellow starthistle	0	0	0.0%
1	*Cotoneaster franchetii*	orange cotoneaster	7	3	9.1%
1	*Cotoneaster pannosus*	silverleaf cotoneaster	6	4	12.1%
1	*Euphorbia oblongata*	eggleaf or oblong spurge	0	0	0.0%
1	*Helichrysum petiolare*	licorice plant	0	0	0.0%
1	*Hypericum perforatum*	Klamathweed	0	0	0.0%
1	*Robinia pseudoacacia*	black locust	0	0	0.0%
1	*Ulex europaea*	gorse, furze	0	0	0.0%
2	*Aptenia cordifolia*	heartleaf iceplant	0	0	0.0%
2	*Arctotheca calendula*	capeweed	4	4	12.1%
2	*Carpobrotus chilensis*	sea fig	0	0	0.0%
2	*Carpobrotus edulis*	hottentot fig, freeway iceplant	29	9	27.3%
2	*Cortaderia jubata*	Andean or purple pampas grass, jubata grass	6	3	9.1%
2	*Cortaderia selloana*	Uruguayan pampas grass	1	1	3.0%
2	*Cytisus scoparius*	Scotch broom	1	1	3.0%
2	*Delairea odorata*	cape ivy	2	2	6.1%
2	*Digitalis purpurea*	purple foxglove	7	5	15.2%
2	*Dipsacus sativus*	Indian teasel	0	0	0.0%
2	*Echium candicans*	pride of Madeira	1	1	3.0%
2	*Ehrharta erecta*	panic veldt grass	5	4	12.1%
2	*Eucalyptus globulus*	bluegum eucalyptus	5	3	9.1%
2	*Foeniculum vulgare*	sweet fennel	9	6	18.2%
2	*Genista monspessulana*	French broom	8	5	15.2%
2	*Hedera helix*	English ivy	6	4	12.1%
2	*Ilex aquifolium*	English holly	12	5	15.2%
2	*Linaria vulgaris*	butter and eggs	2	2	6.1%
2	*Marrubium vulgare*	horehound	0	0	0.0%
2	*Melilotus alba*	white sweetclover	1	1	3.0%
2	*Melilotus indica*	sourclover	0	0	0.0%
2	*Oxalis pes-caprae*	Bermuda buttercup	0	0	0.0%
2	*Paspalum dilatatum*	dallis grass	0	0	0.0%

Table 4. PORE Occurrences and subwatersheds based on 2008 field results. Percentages based on 33 subwatersheds searched (continued).

2008 List	Scientific Name	Common Name	Number of occurences	Number of subwatersheds	Percent subwatersheds with species
2	*Pennisetum clandestinum*	Kikuyu grass	0	0	0.0%
2	*Phalaris aquatica*	Harding grass	28	11	33.3%
2	*Pittosporum undulatum*	Victorian box	0	0	0.0%
2	*Rubus discolor [procerus]*	Himalayan blackberry	10	9	27.3%
2	*Vinca major*	periwinkle	10	6	18.2%
2	*Xanthium spinosum*	spiny cockleburr	2	2	6.1%
3	*Acacia longifolia*	Sydney golden wattle	0	0	0.0%
3	*Acacia melanoxylon*	blackwood acacia	3	2	6.1%
3	*Acacia verticillata*	prickly Moses			0.0%
3	*Albizia lophantha*	silk tree, cape wattle	0	0	0.0%
3	*Anthemis cotula*	chamomile, dog fennel	0	0	0.0%
3	*Bellardia trixago*	bellardia	0	0	0.0%
3	*Berberis darwinii*	Darwin's berberis	1	1	3.0%
3	*Brassica rapa*	field mustard	0	0	0.0%
3	*Briza maxima*	big quakinggrass	1	1	3.0%
3	*Carduus pycnocephalus*	Italian thistle	0	0	0.0%
3	*Carduus tenuiflorus*	slender-flowered thisle	0	0	0.0%
3	*Cichorium intybus*	chicory	0	0	0.0%
3	*Cirsium vulgare*	bull thistle	3	2	6.1%
3	*Conium maculatum*	poison hemlock	7	7	21.2%
3	*Crataegus monogyna*	singleseed hawthorn	0	0	0.0%
3	*Datura stramonium*	jimsonweed, thorn apple	1	1	3.0%
3	*Dipsacus fullonum*	common teasel, Fuller's teasel	1	1	3.0%
3	*Drosanthemum floribundum*	showy dewflower	0	0	0.0%
3	*Echium plantagineum*	salvation jane	0	0	0.0%
3	*Erechtites glomerata*	Australian fireweed, cutleaf burnweed	14	5	15.2%
3	*Erechtites minima*	Australian fireweed, coastal burnweed	13	5	15.2%
3	*Hirschfeldia incana*	shortpod mustard	2	2	6.1%
3	*Holcus lanatus*	velvet grass, Yorkshire fog	16	11	33.3%
3	*Hypericum calycinum*	Aaron's beard	0	0	0.0%
3	*Hypochaeris glabra*	smooth catsear			0.0%
3	*Leontodon taraxacoides* ssp.*longirostris*	lesser hawkbit			0.0%

Table 4. PORE Occurrences and subwatersheds based on 2008 field results. Percentages based on 33 subwatersheds searched (continued).

2008 List	Scientific Name	Common Name	Number of occurences	Number of subwatersheds	Percent subwatersheds with species
3	*Lepidium strictum*	upright pepperweed	0	0	0.0%
3	*Lythrum hyssopifolia*	hyssop loosestrife	0	0	0.0%
3	*Mentha pulegium*	pennyroyal	16	10	30.3%
3	*Myoporum laetum*	myoporum	0	0	0.0%
3	*Pinus radiata*	Monterey pine	2	1	3.0%
3	*Populus alba*	white poplar	0	0	0.0%
3	*Pyracantha angustifolia*	narrowleaf firethorn	1	1	3.0%
3	*Rosa eglanteria*	sweetbriar rose	0	0	0.0%
3	*Rumex acetosella*	sheep sorrel	0	0	0.0%
3	*Scabiosa atropurpurea*	mourningbride	0	0	0.0%
3	*Silybum marianum*	blessed milkthistle	0	0	0.0%
3	*Sorghum halepense*	Johnson grass	0	0	0.0%
3	*Tanacetum parthenium*	feverfew	0	0	0.0%
3	*Verbascum blattaria*	moth mullein	0	0	0.0%
3	*Watsonia meriana*	bulbil bugle-lily	0	0	0.0%
3	*Zantedeschia aethiopica*	calla lily	0	0	0.0%
3.1	*Acroptilon (Centaurea) repens*	Russian knapweed	0	0	0.0%
3.1	*Aegilops triuncialis*	barbed goatgrass	0	0	0.0%
3.1	*Anthoxanthum odoratum*	sweet vernalgrass	7	3	9.1%
3.1	*Brachypodium distachyon*	purple false brome	0	0	0.0%
3.1	*Dittrichia graveolens*	stinkweed	0	0	0.0%
3.1	*Ehrharta calycina*	perennial veldt grass	0	0	0.0%
3.1	*Festuca arundinacea*	tall fescue	0	0	0.0%
3.1	*Salsola soda*	oppositeleaf Russian thistle	0	0	0.0%
5.2	*Ammophila arenaria*	European beachgrass	6	2	6.1%
5.2	*Cakile maritima*	European searocket	7	3	9.1%

3.3 PINN

3.3.1 Search Effort

Eleven miles were surveyed during the 2008 field season at PINN. In total, four individuals combined for 52 hours to complete these surveys; four of these hours were volunteer hours.

3.3.2 Species Found

Two high priority subwatersheds were surveyed in 2008. Both subwatersheds contained List 1, List 2, and List 3.1 species (Tables 6 and 7). One subwatershed contained List 3 species.

Twenty-two occurrences of target weed species were found. Six of these occurrences were List 1, four were List 2, eight were List 3.1, and four were List 3.

Eight species were mapped during surveys, which included one out of eight List 1 species, three of five List 2, two of 16 List 3, and two of 15 List 3.1.

Table 5. Number of invasive species and number of subwatersheds with invasives species found at PINN in 2008.

Measure	Result
Number of List 1 and 2 priority invasive species detections	List 1: 1 of 8 species
	List 2: 3 of 5 species
Number of subwatersheds surveyed with invasive species	List 1: 2 of 2 subwatersheds
	List 2: 2 of 2 subwatersheds

Table 6. PINN Occurrences and subwatersheds based on 2008 field results. Percentages based on 2 subwatersheds searched.

2008 List	Scientific Name	Common Name	Number of occurences	Number of subwatersheds	Percent subwatersheds with species
1	*Acroptilon [Centaurea] repens*	Russian knapweed	0	0	0.0%
1	*Lepidium latifolium*	perennial pepperweed, tall whitetop	0	0	0.0%
1	*Melilotus alba*	white sweetclover	6	2	100.0%
1	*Nicotiana glauca*	tree tobacco	0	0	0.0%
1	*Rubus discolor [procerus]*	Himalayan blackberry	0	0	0.0%
1	*Salsola tragus*	Prickly Russian thistle	0	0	0.0%
1	*Taeniatherum caput-medusae*	Medusahead	0	0	0.0%
1	*Verbascum thapsus*	Woolly mullein	0	0	0.0%
2	*Carduus pycnocephalus*	Italian thistle	2	1	50.0%
2	*Carduus tenuiflorus*	slender-flowered thisle	1	1	50.0%
2	*Conium maculatum*	poison hemlock	1	1	50.0%
2	*Cynodon dactylon*	Bermudagrass	0	0	0.0%
2	*Marrubium vulgare*	horehound	0	0	0.0%
3	*Amaranthus albus*	tumbleweed	0	0	0.0%
3	*Brassica nigra*	black mustard	0	0	0.0%
3	*Brassica rapa*	field mustard	0	0	0.0%
3	*Centaurea melitensis*	Napa thistle, tocalote	0	0	0.0%
3	*Centaurea solstitialis*	yellow starthistle	0	0	0.0%
3	*Cirsium vulgare*	bull thistle	0	0	0.0%
3	*Hirschfeldia incana*	shortpod mustard	0	0	0.0%
3	*Lactuca serriola*	prickly lettuce	0	0	0.0%
3	*Mentha spicata var. spicata*	spearmint	3	1	50.0%
3	*Mentha X piperita*	peppermint	0	0	0.0%
3	*Plantago lanceolata*	English or lanceleaf plantain, ribgrass	0	0	0.0%

Table 6. PINN Occurrences and subwatersheds based on 2008 field results. Percentages based on 2 subwatersheds searched (continued).

2008 List	Scientific Name	Common Name	Number of occurences	Number of subwatersheds	Percent subwatersheds with species
3	*Polygonum arenastrum*	oval-leaf knotweed	0	0	0.0%
3	*Raphanus sativus*	wild radish	0	0	0.0%
3	*Rumex acetosella*	sheep sorrel	0	0	0.0%
3	*Rumex crispus*	curly dock	0	0	0.0%
3	*Silybum marianum*	blessed milkthistle	1	1	50.0%
3.1	*Ailanthus altissima*	tree-of-heaven	0	0	0.0%
3.1	*Chenopodium ambrosioides*	Mexican-tea	0	0	0.0%
3.1	*Dittrichia graveolens*	stinkweed	7	2	100.0%
3.1	*Lolium multiflorum*	Italian or annual ryegrass	0	0	0.0%
3.1	*Lolium perenne*	Italian or perennial ryegrass	0	0	0.0%
3.1	*Lolium temulentum*	darnel	0	0	0.0%
3.1	*Malva parviflora*	cheeseweed	0	0	0.0%
3.1	*Picris echioides*	bristly oxtongue	0	0	0.0%
3.1	*Piptatherum miliaceum*	smilo grass	0	0	0.0%
3.1	*Poa bulbosa*	bulbous bluegrass	0	0	0.0%
3.1	*Tragopogon dubius*	yellow salsify	1	1	50.0%
3.1	*Tribulus terrestris*	puncturevine	0	0	0.0%
3.1	*Trifolium hirtum*	rose clover	0	0	0.0%
3.1	*Verbascum blattaria*	moth mullein	0	0	0.0%
3.1	*Xanthium spinosum*	spiny cockleburr	0	0	0.0%

4.0 Discussion

4.1 Species Ouccurrences

In both GOGA and PORE, the smaller percentage of List 3 species observances is not due to lesser numbers or distribution of these species, but rather because occurrences were only recorded for plants with a patch size of less than 100 m^2, and not all surveys completed were for the entire set of List 1, 2, 3, and 3.1 species. Many of the surveys with volunteer assistance as well as training surveys were conducted using abbreviated plant lists, to facilitate the collection of high-quality data from individuals with less technical plant mapping experience and/or botanical identification skills. The small percentage of all plants mapped in PINN was due to having only one week of surveying which was late in the season after many plants had died back and become difficult to identify.

The numbers of occurrences found for each species may not be a true indication of abundance, as the delineation of individual patches is somewhat subjective for many species. For example, poison hemlock (*Conium maculatum*) can occur across the landscape at low densities (<30% cover) and still be considered a patch, thus creating many large patches of greater than 100 m^2 which are not recorded. Other species, such as jubata grass (*Cortaderia jubata*), can be delineated at a much finer scale, sometimes with individual plants comprising a single patch, resulting in more occurrences. Additionally, detectability can vary during the field season for many species (e.g. oxeye daisy (*Leucanthemum vulgare*) is not obvious from any distance except during its flowering period, whereas Monterey pine (*Pinus radiata*) is obvious year round).

Due to the management concerns of high priority plants as well as small populations of lower priority plants, in addition to occurrences, assessments were also recorded for all List 1 and 3.1 species as well as all List 2 and 3.2 species with a patch size of less than 100 m^2. These assessments are polygons which include the extent and coverage of all weed populations detected and are critically important to assessing the rapid response potential and any change over time of detected populations; this information on patch size is not presented here. Occurrence information alone *can* be sufficient to discern new populations that require rapid response, but a true measure of success for the parks—the reduction in extent of an invasive species—will require amended assessments of weed occurrences or other monitoring of control efforts done by park staff.

4.2 Species List Revisions

The majority of list revisions for GOGA were made after the 2007 season. This made for a more efficient season of surveying for 2008, as data collection time was not spent on those few plants too abundant and widespread for their current listings. After the 2008 field season, additional revisions were made to the priority lists for each park (Tables 7 - 9). Two species found in more than 15 subwatersheds and with over 30 occurrences were shifted to List 3. One species from List 3.2 that was found in more that 15 subwatersheds and had 28 occurrence was also shifted to List 3. One species had occurrences in 14 subwatersheds, with 45 total occurrences, and was shifted from List 1 to List 2. One new species and one List 4 species were added to List 3.1 due to their rapid spread rate and small occurrence size (most consisting of only one plant)—as well

as its high priority for management in the park. Due to the difficulty of identifying one List 2 plant, it was moved to List 3.2.

Table 7. Revisions to the GOGA priority species list for 2009.

Scientific Name	Common Name	2008 List	2009 List	Justification
Anthoxanthum odoratum	sweet vernal grass	n/a	3.1	in GOGA, species of concern
Bromus diandrus	ripgut brome	3.2	3	too abundant
Centaurea melitensis	Napa thistle, tocalote	1	2	too abundant
Conium maculatum	poison hemlock	2	3	too abundant
Hirschfeldia incana	shortpod mustard	2	3.2	difficult genus
Holcus lanatus	velvet grass, Yorkshire fog	2	3	too abundant
Scabiosa atropurpurea	mourningbride	4	3.1	species of concern, not yet widespread

Analysis of search results from PORE showed that some species considered rare within the park were actually much more widespread than expected, while others were not found at all. Also, learning and searching for 13 species proved to be difficult for most volunteers—especially species never found, because search images were not reinforced through an actual detection. Since only five of the 13 highest priority plants were found this year, it may be possible to narrow the list. The plants that were not found, but are still thought to occur somewhere in the park should be moved to List 3.1 (for more advanced observers).

Table 8. Revisions to the PORE priority species list for 2009.

Scientific Name	Common Name	2008 List	2009 List	Justification
Acacia melanoxylon	blackwood acacia	3	2	species of concern, due to increasing infestations
Ageratina adenophora	thoroughwort, crofton weed		3.1	not on 2008 list
Albizia lophantha	silk tree, cape wattle	3	3.1	species of concern, not yet widespread
Allium triquetrum	threecorner leek		W3	not on 2008 list
Ammophila arenaria	European beachgrass	5.2	5.4	too abundant
Anthemis cotula	chamomile, dog fennel	3	4	too abundant
Aptenia cordifolia	heartleaf iceplant	2	4	too abundant
Bellardia trixago	bellardia	3	4	too abundant
Berberis darwinii	Darwin's berberis	3	2	species of concern, not yet widespread
Brassica rapa	field mustard	3	4	too abundant
Briza maxima	big quakinggrass	3	4	too abundant
Cakile edentula	European searocket		5.4	not on 2008 list
Cakile maritima	European searocket	5.2	5.4	too abundant
Carduus pycnocephalus	Italian thistle	3	4	too abundant
Carduus tenuiflorus	slender-flowered thisle	3	4	too abundant
Carpobrotus chilensis	sea fig	2	3	too abundant
Carpobrotus edulis	hottentot fig, freeway iceplant	2	3	too abundant
Centaurea iberica	Iberian starthistle	1	3.1	not found in park
Cichorium intybus	chicory	3	4	too abundant
Cirsium vulgare	bull thistle	3	4	too abundant
Cortaderia jubata	Andean or purple pampas grass, jubata grass	2	3	too abundant
Cortaderia selloana	Uruguayan pampas grass	2	3	too abundant
Cupressus macrocarpa	Monterey cypress		3	not on 2008 list

Table 8. Revisions to the PORE priority species list for 2009 (continued).

Scientific Name	Common Name	2008 List	2009 List	Justification
Datura stramonium	jimsonweed, thorn apple	3	2	species of concern due to potential invasiveness
Digitalis purpurea	purple foxglove	2	3	too abundant
Dipsacus sativus	indian teasel	2	3	too abundant
Ehrharta erecta	panic veldt grass	2	3	too abundant
Erechtites glomerata	Australian fireweed, cutleaf burnweed	3	4	too abundant
Erechtites minima	Australian fireweed, coastal burnweed	3	4	too abundant
Eucalyptus globulus	bluegum eucalyptus	2	3	too abundant
Euphorbia lathyris	gopher plant, caper spurge	4	3	species of concern due to potential invasiveness
Festuca arundinacea	tall fescue	3.1	3	too abundant
Foeniculum vulgare	sweet fennel	2	3	too abundant
Hirschfeldia incana	shortpod mustard	3	4	too abundant
Holcus lanatus	velvet grass, Yorkshire fog	3	4	too abundant
Hypochaeris glabra	smooth catsear	3	4	too abundant
Leontodon taraxacoides ssp.longirostris	lesser hawkbit	3	4	too abundant
Lepidium strictum	upright pepperweed	3	4	too abundant
Leucanthemum vulgare	ox-eye daisy	4	2	high priority for PORE management due to increasing infestations
Ludwigia peploides	floating primrose-willow		4	not on 2008 list
Marrubium vulgare	horehound	2	3.1	species of concern, not yet widespread
Melilotus alba	white sweetclover	2	4	too abundant
Meliotus indica	sourclover	2	4	too abundant
Oxalis pes-caprae	Bermuda buttercup	2	W2	only visible during short window of time
Paspalum dilatum	dallis grass	2	3.1	species of concern
Robinia pseudoacacia	black locust	1	3.1	not found in park
Romulea rosea var. australis	rosy sandcrocus	4	W4	only visible during short window of time
Rosa canina	dog rose		4	not on 2008 list
Rumex acetosella	sheep sorrel	3	4	too abundant
Senecio jacobaea	tansy ragwort, stinking willie		3.1	not on 2008 list
Silybum marianum	blessed milkthistle	3	4	too abundant
Solanum nigrum	black nightshade		4	not on 2008 list
Sparaxis tricolor	harlequinflower, wandflower		W3	not on 2008 list
Tetragonia tetragonoides	New Zealand-spinach		2	not on 2008 list

4.3 Outreach

Education and outreach plays a critical role in the engagement of a network of early detectors. A number of "Weed ID" classes were held for GOGA staff, volunteers, interns, Golden Gate National Parks Conservancy staff, and Point Reyes NS volunteers, as discussed in Section 2.4. In total, nine classes were held with 26 individuals in attendance. Additionally, two Geoweed/invasive plant mapping trainings were held with 25 attendees. Whenever possible, volunteers were trained on an individual basis to conduct early detection surveys and map incipient populations of target pest plants.

Web pages were enhanced to provide support to Weed Watcher participants (http://science.nature.nps.gov/im/units/sfan/vital_signs/Invasives/weed_watchers.cfm). Online versions of the "Plant-out-of-Place" cards, a narrative explaining the necessity for invasive plant early detection, and information about how to take part in the Weed Watcher program are featured on the web pages. Maps and data sheets were added to the site in 2008. The potential exists to expand these pages to provide online trainings, more interactive maps, and links to reporting. Until we can track the number of hits to this page, we will be unable to measure the success of online outreach well. A voluntary form generally submittable online (depending on email system and permissions) registered one download of the ID cards from a teacher in the California Bay Area.

Further development of the volunteer component of the early detection program at the SFAN parks will undoubtedly result in increasing the potential for new detections along the trail and road corridors of the parks. While drop-in volunteers are limited in their capacity for identifying more than a few new plants to them and thus performing Weed Watcher surveys, encouraging drop-ins is a necessary tool for volunteer recruitment and expanding citizen involvement.

4.4 Collaboration

Early detection is ineffective without rapid assessment and response to invasions. The SFAN I&M Network of parks has many invasive plant management teams that manage incipient and established weed populations. The importance of both collaboration and communication with these management teams is imperative to the success of an early detection program.

At GOGA there are several groups that manage invasive species. The Habitat Restoration Team (HRT), under the direction of Maria Alvarez, has adopted the GeoWeed data management system. In addition, the HRT's Invasive Plant Patrol (IPP) roving hikes now include early detection surveys as part of their protocol. There is potential to augment the existing IPP hikes with Weed Watcher hikes to cover a larger area of GOGA. The HRT works at sites throughout the park, and are host to a sizeable volunteer program of knowledgeable people who have the capacity to respond to new invasions. Continued coordination with the HRT is critical to any successful early detection program at this park.

The Golden Gate National Parks Conservancy (GGNPC) also houses several weed management programs that have participated in the Weed Watcher program including the Native Plant Nurseries at Muir Woods, the Marin Headlands, and the Presidio. The Site Stewardship restoration programs housed at the GGNPC manage areas in Sweeney Ridge, Mori Point, and Tennessee Valley. These groups also have made commitments to utilize the GeoWeed data management system, which would facilitate communication among programs.

Point Reyes National Seashore has a well-established weed management program with an affiliated volunteer program, the Habitat Restoration Program (HRP). Ellen Hamingson leads the HRP program and worked closely with the Weed Watcher program in 2008 to implement rapid response treatment for many of the infestions that were mapped by the Weed Watchers. Continuing work is planned for 2009, including the addition of two early detection and rapid response interns who will be working at both PORE and GOGA.

Also housed at Point Reyes NS is the California Exotic Plant Management Team (EPMT) which is responsible for managing weed populations at national parks across California. The EPMT program is integral to rapid response at parks that are not served by in-house management programs, or as an augmentation to existing programs.

With the help of the resource staff at Pinnacles National Monument, high priority areas were surveyed using the newly developed species list. A PINN GeoWeed database was developed and the results of the 2008 surveys were entered into this database with the anticipation that PINN park staff will adopt GeoWeed for their everyday invasive plant managaemnt needs. Further development of this program should occur in 2009.

Further work at other SFAN network parks is necessary to ensure that findings will be communicated to the responsible entities for rapid response. Reliance upon shared data via the GeoWeed system is only one step in a communication process that should include an alert system of emails, reports, and phone calls. This component of the Weed Watcher program needs to be streamlined and formalized, so that responsible entities for each region of network parks can be notified in a timely manner about Weed Watcher findings.

As network parks share borders with many other land management agencies, an integrated approach is key to stopping the spread of new invaders. In addition to working with the network of parks, I&M staff have helped to secure grant funding to build a true Bay Area Early Detection Network (BAEDN) for the nine-county area. An initial partner interest meeting in December 2006 was followed by intermittent conference calls and presentations, and resulted in a coalition of over 50 potentially and actively interested organizations representing national, state and local agencies, nonprofits, and individuals. With funds delivered in 2009, work will begin in earnest and is expected to include online reporting, hiring a coordinator for BAEDN, and trainings based largely on SFAN protocols, so that parks will no longer be limited to seeing only what is within our borders.

6.0 Literature Cited

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7.0 Glossary

Assessments: Surveys and monitoring of isolated weeds and weed population *occurrences* are defined and recorded in the database as individual *assessments*. An *assessment* therefore is a set of measurements taken over time, recorded for a specified weed *occurrence*. Each *assessment* relates to one specific *occurrence*, while each *occurrence* can accrue a series of *assessments* over time. An *assessment* for each *occurrence* can be recorded as a point, a line, or a polygon. *Assessments* will be used to depict the size, scale, and coverage of an occurrence and therefore will be used as a basis for monitoring the project's effectiveness. The initial *occurrence* and *assessment* data will serve as the baseline for the entire project area, and the project area will be re-assessed regularly for the duration of the project. These periodic *assessments* will be used to determine if weed populations are increasing or decreasing in size and distribution and if *treatments* are having the desired effects.

Exotic: Occurring in a given place as a result of direct or indirect, deliberate or accidental actions by humans. Synonyms: alien, introduced, non-native, and non-indigenous.

GeoWeed: The Microsoft Access-based database developed by the Sonoma Ecology Center from the Weed Information Management System. GeoWeed is a relational database that offers digital data collection of management and spatial weed data through ESRI ArcPad applets. The San Francisco Bay Area Network uses GeoWeed for its Early Detection data. Additional information available in SFAN's protocol and at http://geoweed.org.

Invasive: Tending to spread, intrude, or encroach, usually aggressively and in a hurtful manner. Gardeners characterize cultivated plants as "invasive" when they spread aggressively beyond where they were intended to remain, particularly if they outcompete and displace other plants in the garden. Native species can behave invasively, but this term generally connotes non-natives which can spread into undisturbed ecosystems.

Invasive species: Official term for an exotic species whose introduction can cause economic or environmental harm or harm to human health. The term originated in Presidential Executive Order 13112 issued February 3, 1999.

IPP: Invasive Plant Patrol. Early detection program implemented at Golden Gate National Recreation Area.

Management units: Areas to be monitored for new species/infestations. A management unit may be the entire park, critical habitat within a park, or areas of concern given their proximity to known entry points. Some parks define areas by watershed, others use site names–both are considered a management unit.

Occurrences: The weed *occurrence* is the basic unit of mapping and assessing a singular weed or weed population/infestation within WIMS and GeoWeed. Each *occurrence* defines the presence of a single species and is recorded at a specific location. The *occurrence* location is recorded as a point in space, although each *occurrence* may actually be a population of plants covering an extensive area.

Regions: A region is a uniquely named parcel of land that may have either legally defined boundaries or locally derived place names. In the protocol we may use up to three *regions* to locate each *occurrence;* one is mandatory: the sub-watershed (*e.g*. Fort Mason is in GGNRA26-3). *Regions* are synonymous with *area* in WIMS.

SOP: Standard Operating Procedures. These are the detailed steps explaining how to carry out the monitoring protocol.

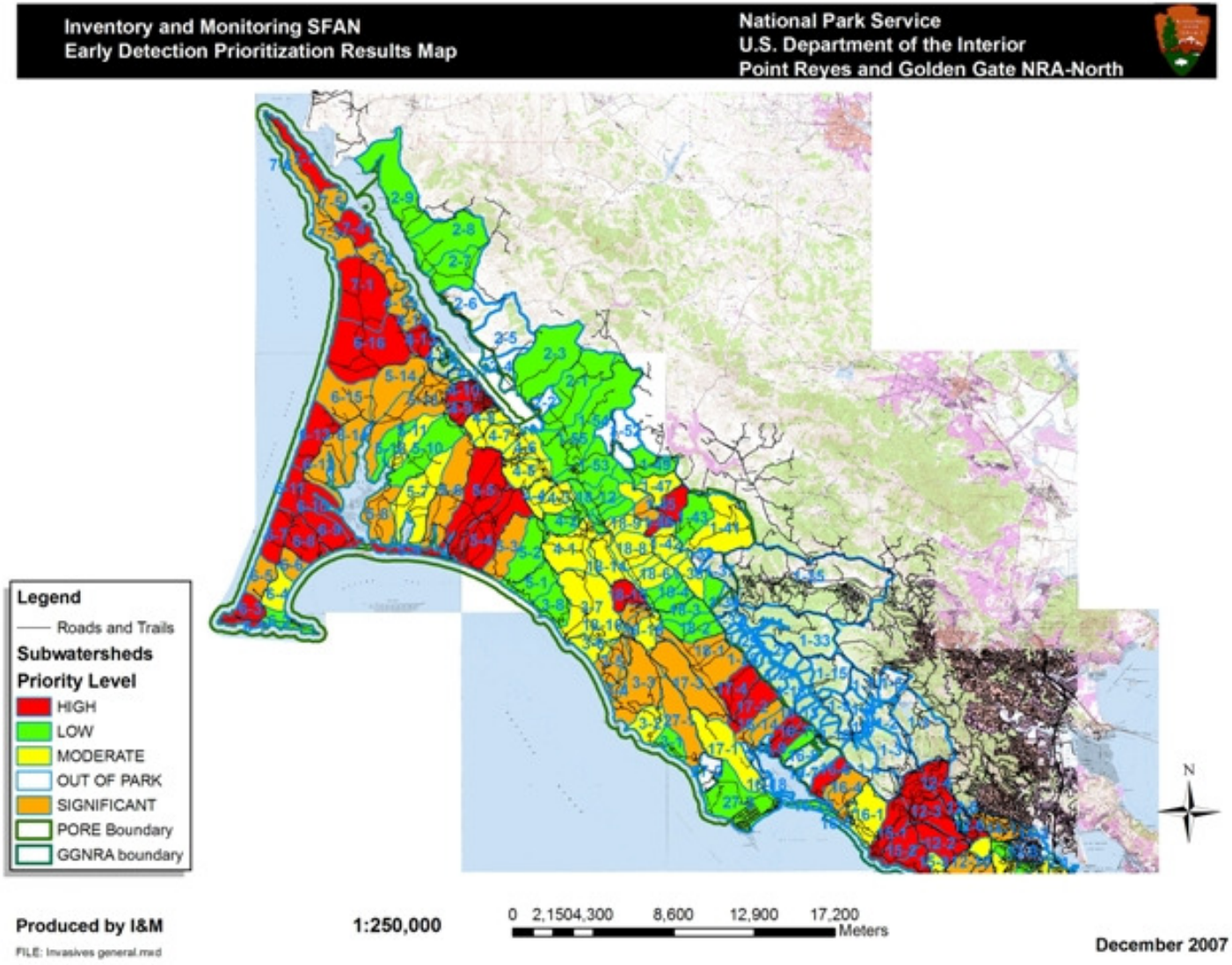
Subwatershed: A management unit subunit of a watershed, based largely on drainages, and used to track weed work in GOGA.

Survey area: A point with typed-in length and width data, the *survey area* is mapped and documented each survey as a way of showing what area was surveyed, thus showing where target species were NOT found. The *survey area* tab in GeoWeed allows collection of negative data (species name with 0% cover and no phenology information), as well as a full inventory of plants seen (species name, % cover, phenology, identification confidence and reason for doubt). The *survey area* point is augmented by a tracklog for more detailed visualization of the survey route.

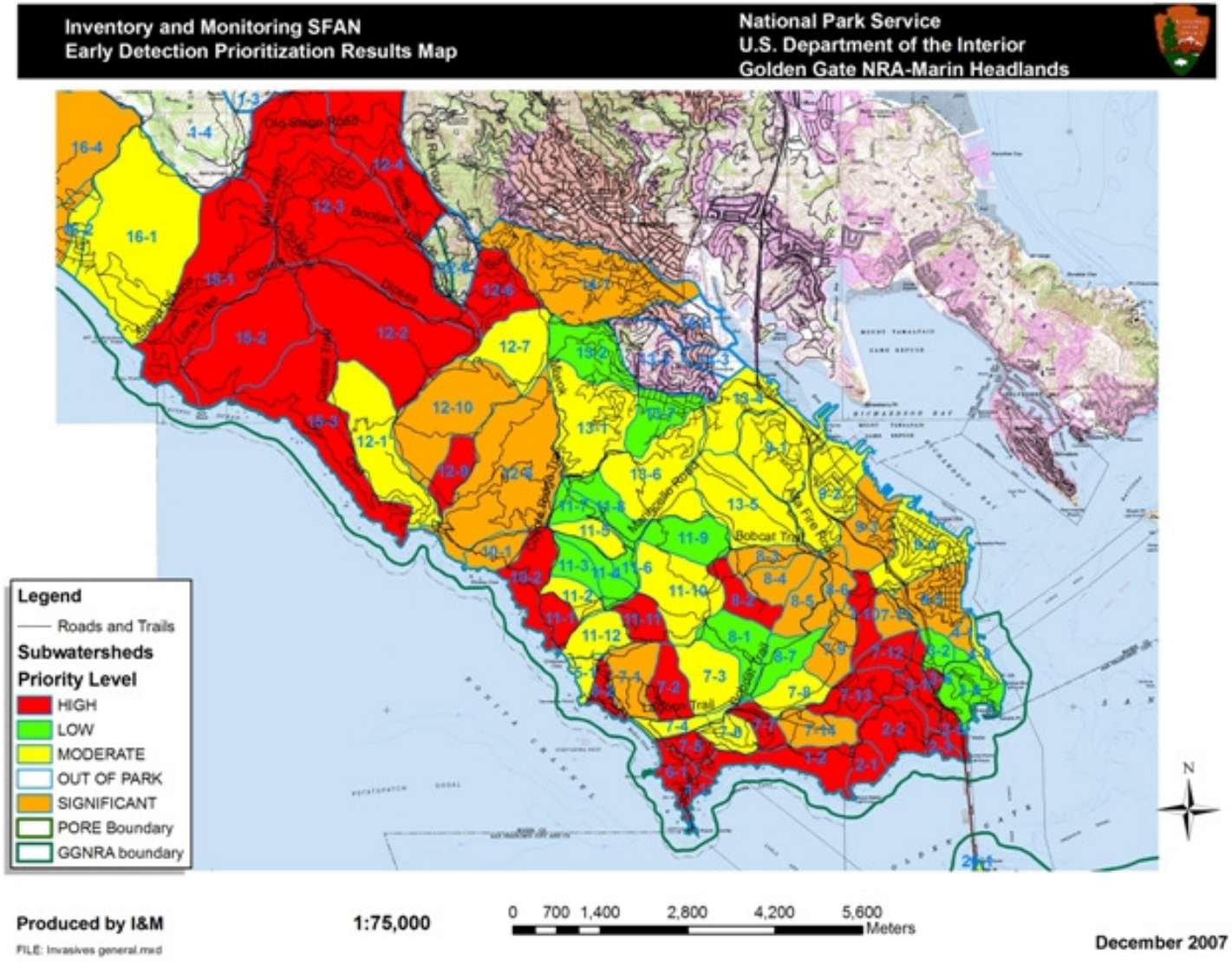
Treatments: A *treatment* is any weed management activity that occurs at a specific time over a defined geographical area. One *treatment* may affect one or more *occurrences* (of one or several species) over one or more *regions*. The WIMS and GeoWeed databases track all types of weed control methods, including manual and mechanical methods, prescribed fire, grazing, biological control, and any chemical treatments. The database also keeps track of how much staff and/or volunteer time has been spent controlling weeds.

Weed: A weed is a plant out of place. The term “noxious weed” is an official designation for weeds which cause economic harm. More precise, accepted, and general terms for environmentally harmful non-natives are exotic pest plant (although “pest” has a legal definition of causing harm, similar to “noxious”) and invasive plant species. In Australia, exotic pest plants are termed environmental weeds.

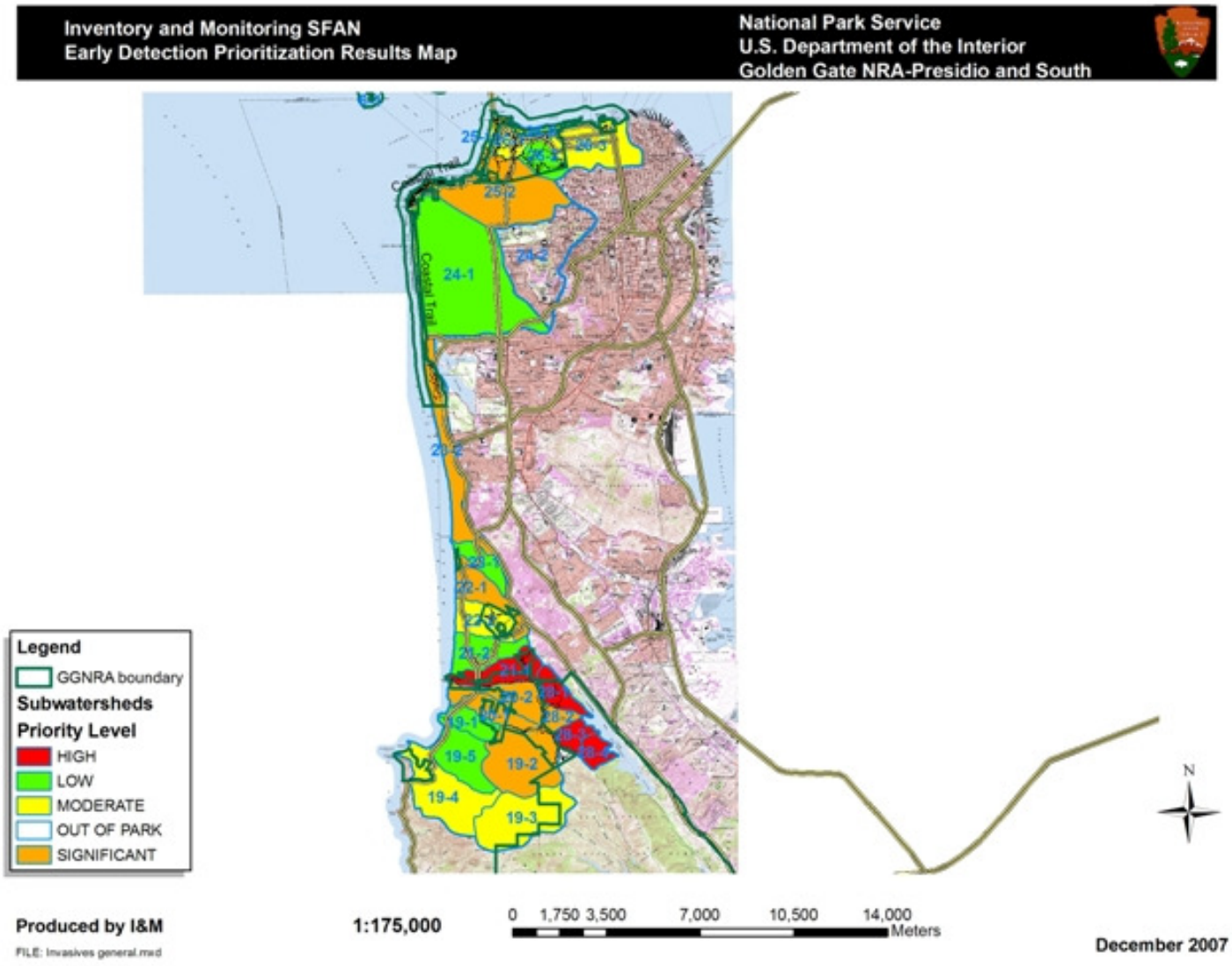
Appendix A. Maps showing prioritized subwatersheds.



Appendix A. Maps showing prioritized subwatersheds. (continued)



Appendix A. Maps showing prioritized subwatersheds. (continued)



Appendix B: List of priority invasive species by park (2008).

Golden Gate, Muir Woods, Presidio and Fort Point: Priority 1 Species: Point occurrences and polygon assessments.

Scientific Name	Common Name	Family	PLANTS Code
Arctotheca calendula	capeweed	Asteraceae	ARCA45
Centaurea calcitrapa	purple starthistle	Asteraceae	CECA2X
Centaurea melitensis	Napa thistle, tocalote	Asteraceae	CEME2X
Cortaderia selloana	Uruguayan pampas grass	Poaceae	COSE4X
Cytisus scoparius	Scotch broom	Fabaceae	CYSC4X
Cytisus striatus	Portugese broom, striated broom	Fabaceae	CYST7X
Digitalis purpurea	purple foxglove	Scrophulariaceae	DIPUXX
Euphorbia oblongata	eggleaf or oblong spurge	Euphorbiaceae	EUOB4X
Helichrysum petiolare	licorice plant	Asteraceae	HEPE8X
Ilex aquifolium	English holly	Aquifoliaceae	ILAQ80
Ulex europaea	gorse, furze	Fabaceae	ULEUXX
Vinca major	periwinkle	Apocynaceae	VIMAXX

Golden Gate, Muir Woods, Presidio and Fort Point: Priority 2 Species: Point occurrences and polygon assessments (if patch size <100m^2)

Scientific Name	Common Name	Family	PLANTS Code
Acacia melanoxylon	blackwood acacia	Fabaceae	ACMEXX
Ageratina adenophora	thoroughwort, crofton weed	Asteraceae	AGAD2X
Conium maculatum	poison hemlock	Apiaceae	COMA2X
Delairea odorata	cape ivy	Asteraceae	DEODXX
Dipsacus fullonum	common teasel, Fuller's teasel	Dipsacaceae	DIFU2X
Eucalyptus globulus	bluegum eucalyptus	Myrtaceae	EUGLXX
Hedera helix	English ivy	Araliaceae	HEHEXX
Hirschfeldia incana	shortpod mustard	Brassicaceae	HIIN3X
Holcus lanatus	velvet grass, Yorkshire fog	Poaceae	HOLAXX
Leucanthemum vulgare	ox-eye daisy	Asteraceae	LEVUXX
Mentha pulegium	pennyroyal	Lamiaceae	MEPUXX
Oxalis pes-caprae	Bermuda buttercup	Oxalidaceae	OXPEXX
Rubus discolor [*procerus, armeniacus*]	Himalayan blackberry	Rosaceae	RUDI2X

Appendix B: List of priority invasive species by park (2008) (continued).

Golden Gate, Muir Woods, Presidio and Fort Point: Priority 3 Species: Presence/absence, or point occurrences (if patch size <100m^2).

Scientific Name	Common Name	Family	PLANTS Code
Brassica rapa	field mustard	Brassicaceae	BRRAXX
Briza maxima	big quakinggrass	Poaceae	BRMAXX
Carpobrotus edulis	hottentot fig, freeway iceplant	Aizoaceae	CAED3X
Cortaderia jubata	Andean or purple pampas grass, jubata grass	Poaceae	COJU2X
Cotoneaster franchetii	orange cotoneaster	Rosaceae	COFR3X
Cotoneaster pannosus	silverleaf cotoneaster	Rosaceae	COPA14
Ehrharta erecta	panic veldt grass	Poaceae	EHERXX
Erechtites glomerata	Australian fireweed, cutleaf burnweed	Asteraceae	ERGL8X
Erechtites minima	Australian fireweed, coastal burnweed	Asteraceae	ERMI6X
Foeniculum vulgare	sweet fennel	Apiaceae	FOVUXX
Genista monspessulana	French broom	Fabaceae	GEMO2X
Phalaris aquatica	Harding grass	Poaceae	PHAQXX
Pinus radiata	Monterey pine	Pinaceae	PIRA2X
Rumex acetosella	sheep sorrel	Polygonaceae	RUAC3X
Schinus molle	pepper tree	Anacardiaceae	SCMOXX
Tamarix chinensis	saltcedar	Tamaricaceae	TACH2X
Xanthium spinosum	spiny cockleburr	Asteraceae	XASP2X
Xanthium strumarium	rough cockleburr	Asteraceae	XASTXX

Golden Gate, Muir Woods, Presidio and Fort Point: Priority 3.1 Species: Point occurrences and polygon assessments.

Scientific Name	Common Name	Family	PLANTS Code
Ailanthus altissima	tree-of-heaven	Simaroubaceae	AIALXX
Albizia lophantha	silk tree; cape wattle	Fabaceae	ALLOXX
Berberis darwinii	Darwin's berberis	Berberidaceae	BEDAXX
Brachypodium distachyon	purple false brome	Poaceae	BRDI2X
Carduus acanthoides	plumeless thistle	Asteraceae	CAACXX
Carthamus lanatus	woolly distaff thistle	Asteraceae	CALA20
Centaurea solstitialis	yellow starthistle	Asteraceae	CESO3X
Cirsium arvense	Canada thistle	Asteraceae	CIAR4X
Crataegus monogyna	singleseed hawthorn	Rosaceae	CRMOXX
Cynara cardunculus	artichoke thistle	Asteraceae	CYCAXX
Cynodon dactylon	Bermudagrass	Poaceae	CYDAXX
Dittrichia graveolens	stinkweed	Asteraceae	DIGR4X
Echium plantagineum	salvation jane	Boraginaceae	ECPLXX
Ehrharta calycina	perennial veldt grass	Poaceae	EHCAXX
Hedera canariensis	Algerian ivy	Araliaceae	HECAXX

Appendix B: List of priority invasive species by park (2008) (continued).

Golden Gate, Muir Woods, Presidio and Fort Point: Priority 3.1 Species: Point occurrences and polygon assessments (continued).

Scientific Name	Common Name	Family	PLANTS Code
Hypericum perforatum	Klamathweed	Clusiaceae	HYPEXX
Nicotiana glauca	tree tobacco	Solanaceae	NIGLXX
Phalaris arundinacea	reed canary grass	Poaceae	PHAR3X
Pittosporum crassifolium	stiffleaf cheesewood	Pittosporaceae	PICRXX
Pyracantha angustifolia	narrowleaf firethorn	Rosaceae	PYANXX
Robinia pseudoacacia	black locust	Fabacae	ROPSXX
Spartium junceum	Spanish broom	Fabaceae	SPJU2X

Golden Gate, Muir Woods, Presidio and Fort Point: Priority 3.2 Species: Point occurrences and polygon assessments (if patch size <100m^2).

Scientific Name	Common Name	Family	PLANTS Code
Bromus diandrus	ripgut brome	Poaceae	BRDI3X
Bromus madritensis ssp. *rubens*	red brome	Poaceae	BRMARX
Bromus tectorum	cheat grass, downy brome	Poaceae	BRTEXX
Dactylis glomerata	orchard grass, cocksfoot	Poaceae	DAGLXX
Festuca arundinacea	tall fescue	Poaceae	FEAR3X
Leptospermum laevigatum	Australian teatree	Myrtaceae	LELA29
Pennisetum clandestinum	Kikuyu grass	Poaceae	PECL2X
Rosa eglanteria	sweetbriar rose	Rosaceae	ROEGXX

Golden Gate, Muir Woods, Presidio and Fort Point: Priority 4 Species: Presence/absence (advanced observers).

Scientific Name	Common Name	Family	PLANTS Code
Acacia baileyana	□ootamundra wattle	Fabaceae	ACBAXX
Acacia dealbata	silver wattle	Fabaceae	ACDE3X
Acacia decurrens	green wattle	Fabaceae	ACDEXX
Acacia longifolia	Sydney golden wattle	Fabaceae	ACLOXX
Acacia mearnsii	black wattle	Fabaceae	ACME80
Acacia verticillata	prickly Moses	Fabaceae	ACVE2X
Allium triquetrum	threecorner leek	Liliaceae	ALTR4X
Alopecurus pratensis	meadow foxtail	Poaceae	ALPR3X
Amaryllis belladonna	belladonna lily	Liliaceae	AMBE3X
Anredera cordifolia	Madeira vine	Basellaceae	ANCO6X
Arrhenatherum elatius	tall oatgrass	Poaceae	AREL3X
Barbarea verna	early yellowrocket	Brassicaceae	BAVEXX

Appendix B: List of priority invasive species by park (2008) (continued).

Golden Gate, Muir Woods, Presidio and Fort Point: Priority 4 Species: Presence/absence (advanced observers) (continued).

Scientific Name	Common Name	Family	PLANTS Code
Barbarea vulgaris	winter cress	Brassicaceae	BAVUXX
Bellardia trixago	bellardia	Scrophulariaceae	BETRXX
Brassica nigra	black mustard	Brassicaceae	BRNIXX
Briza minor	little quakinggrass	Poaceae	BRMI2X
Bromus catharticus	rescue grass	Poaceae	BRCA6X
Bromus hordeaceus	soft brome	Poaceae	BRHO2X
Bromus stamineus	roadside brome	Poaceae	BRST3X
Calendula arvensis	field marigold	Asteraceae	CAARXX
Carduus tenuiflorus	slender-flowered thistle	Asteraceae	CATU2X
Centaurea diluta	North African knapweed	Asteraceae	CEDI4X
Centranthus ruber	red valerian	Valerianaceae	CERU2X
Cestrum aurantiacum	orange jessamine	Solanaceae	CEAU2X
Chrusanthemum segetum	corndaisy	Asteraceae	CHSEXX
Coprosma repens	creeping mirrorplant	Rubiaceae	CORE4X
Cotula australis	Australian waterbuttons	Asteraceae	COAU3X
Cotula coronopifolia	brassbuttons	Asteraceae	COCO7X
Crocosmia X *crocosmiiflora*	crocosmia, montbretia	Iridaceae	CRCR6X
Cupressus macrocarpa	Monterey cypress	Cupressaceae	CUMA2X
Cytisus multiflorus	white spanishbroom	Fabaceae	CYMU3X
Daucus carota	Queen Anne's lace, wild carrot	Apiaceae	DACA6X
Digitaria sanguinalis	crabgrass	Poaceae	DISAXX
Dipsacus sativus	Indian teasel	Dipsacaceae	DISA9X
Duchesnea indica	mock-strawberry	Rosaceae	DUINXX
Echium candicans	pride of Madeira	Boraginaceae	ECCA5X
Epipactis helleborine	broadleaf helleborine	Orchidacaea	EPHEXX
Erigeron karvinskianus	Latin American fleabane	Asteraceae	ERKA2X
Escallonia rubra	redclaws	Grossulariaceae	ESRU4X
Euphorbia peplus	petty spurge	Euphorbiaceae	EUPE6X
Geranium retrorsum	New Zealand geranium	Geraniaceae	GEREXX
Gunnera tinctoria	Chilean gunnera	Gunneraceae	GUTIXX
Hainardia cylindrica	barbgrass	Poaceae	HACYXX
Hedypnois cretica	Cretanweed	Asteraceae	HECR2X
Hypericum calycinum	Aaron's beard	Clusiaceae	HYCA10
Ipomoea mutabilis	oceanblue morning-glory	Convolvulaceae	IPMU6X
Kniphofia uvaria	redhot poker	Liliaceae	KNUV80
Lathyrus latifolius	everlasting pea, perennial pea	Fabaceae	LALA4X
Lepidium strictum	upright pepperweed	Brassicaceae	LEST2X
Leucanthemum maximum	Shasta daisy and hybrids	Asteraceae	LEMA8X
Ligustrum ovalifolium	california privet	Oleaceae	LIOVXX
Linaria vulgaris	butter and eggs	Scrophulariaceae	LIVU2X

Appendix B: List of priority invasive species by park (2008) (continued).

Golden Gate, Muir Woods, Presidio and Fort Point: Priority 4 Species: Presence/absence (advanced observers) (continued).

Scientific Name	Common Name	Family	PLANTS Code
Lobularia maritima	sweet alyssum	Brassicaceae	LOMAXX
Lonicera japonica	Japanese honeysuckle	Caprifoliaceae	LOJAXX
Marrubium vulgare	horehound	Lamiaceae	MAVUXX
Mentha spicata var. spicata	spearmint	Lamiaceae	MESP3X
Mentha X *piperita*	peppermint	Lamiaceae	MEPIXX
Muehlenbeckia complexa	maidenhair vine	Polygonaceae	MUCO3X
Myosotis discolor	yellow and blue forget-me-not	Boraginaceae	MYDIXX
Myosotis latifolia	broadleaf forget-me-not	Boraginaceae	MYLA4X
Narcissus pseudonarcissus	common daffodil	Liliaceae	NAPSXX
Nerium oleander	oleander	Apocynaceae	NEOLXX
Parapholis incurva	curved sicklegrass	Poaceae	PAINXX
Parentucellia viscosa	yellow glandweed	Scrophulariaceae	PAVI3X
Paspalum dilatatum	dallis grass	Poaceae	PADI3X
Phalaris canariensis	annual canarygrass	Poaceae	PHCA5X
Phalaris minor	littleseed canarygrass	Poaceae	PHMI3X
Phalaris paradoxa	hood canarygrass	Poaceae	PHPA5X
Pittosporum undulatum	Victorian box	Pittosporaceae	PIUN2X
Polycarpon tetraphyllum	fourleaf manyseed	Caryophyllaceae	POTEXX
Prunus avium	bird cherry	Rosaceae	PRAVXX
Prunus cerasifera	cherry plum	Rosaceae	PRCE2X
Ranunculus muricatus	spinyfruit buttercup	Ranunculaceae	RAMU2X
Ranunculus repens	creeping buttercup	Ranunculaceae	RARE3X
Raphanus sativus	wild radish	Brassicaceae	RASA2X
Scabiosa atropurpurea	mourningbride	Dipsacaceae	SCATXX
Schinus molle	pepper tree	Anacardiaceae	SCMOXX
Senecio elegans	redpurple ragwort	Asteraceae	SEELXX
Sinapis arvensis	charlock	Brassicaceae	SIAR4X
Solanum marginatum	white-margined nightshade	Solanaceae	SOMAXX
Sparaxis tricolor hybrid	Harlequin flower	Iridaceae	SPTRXX
Tanacetum parthenium	feverfew	Asteraceae	TAPA6X
Tetragonia tetragonioides	New Zealand-spinach	Aizoaceae	TETE3X
Tropaeolum majus	nasturtium	Tropaeolaceae	TRMA7X
Verbascum blattaria	moth mullein	Scrophulariaceae	VEBLXX
Watsonia borbonica	bugle-lily	Iridaceae	WABOXX
Watsonia marginata	fragrant bugle-lily	Iridaceae	WAMA2X
Watsonia meriana	bulbil bugle-lily	Iridaceae	WAMEXX
Zantedeschia aethiopica	calla lily	Araceae	ZAAEXX

Appendix B: List of priority invasive species by park (2008) (continued).

Golden Gate, Muir Woods, Presidio and Fort Point: Priority 5 Species: (Dune and Aquatic).

Scientific Name	Common Name	Family	PLANTS Code
Ammophila arenaria	European beachgrass	Poaceae	AMAR4X
Ammophila breviligulata	American beachgrass	Poaceae	AMBRXX
Aptenia cordifolia	heartleaf iceplant	Aizoaceae	APCOXX
Arundo donax	giant reed	Poaceae	ARDO4X
Carpobrotus chilensis	sea fig	Aizoaceae	CACH38
Conicosia pugioniformis	narrow-leaved iceplant	Aizoaceae	COPU18
Drosanthemum floribundum	showy dewflower	Aizoaceae	DRFL2X
Eichhornia crassipes	water hyacinth	Pontederiaceae	EICRXX
Mesembryanthemum crystallinum	ice plant	Aizoaceae	MECR3X
Myriophyllum aquaticum	parrot's-feather	Haloragaceae	MYAQ2X
Myriophyllum spicatum	Eurasian watermilfoil	Haloragaceae	MYSP2X
Spartina alterniflora	Atlantic or smooth cordgrass	Poaceae	SPALXX

Point Reyes: Priority 1 Species: Point occurrences and polygon assessments.

Scientific Name	Common Name	Family	PLANTS Code
Carduus acanthoides	plumeless thistle	Asteraceae	CAACXX
Carthamus lanatus	woolly distaff thistle	Asteraceae	CALA20
Centaurea calcitrapa	purple starthistle	Asteraceae	CECA2X
Centaurea iberica	Iberian starthistle	Asteraceae	CEIBXX
Centaurea melitensis	Napa thistle, tocalote	Asteraceae	CEME2X
Centaurea solstitialis	yellow starthistle	Asteraceae	CESO3X
Cotoneaster franchetii	orange cotoneaster	Roseaceae	COFR3X
Cotoneaster pannosus	silverleaf cotoneaster	Roseaceae	COPA14
Euphorbia oblongata	egglear or oblong spurge	Euphorbiaceae	EUOB4X
Helichrysum petiolare	licorice plant	Asteraceae	HEPE8X
Hypericum perforatum	Klamathweed	Clusiaceae	HYPEXX
Robinia pseudoacacia	black locust	Fabaceae	ROPSXX
Ulex europaea	gorse, furze	Fabaceae	ULEUXX

Appendix B: List of priority invasive species by park (2008) (continued).

Point Reyes: Priority 2 Species Point occurrences and polygon assessments (if patch size <100m^2)

Scientific Name	Common Name	Family	PLANTS Code
Aptenia cordifolia	heartleaf iceplant	Aizoaceae	APCO
Arctotheca calendula	capeweed	Asteraceae	ARCA45
Carpobrotus chilensis	sea fig	Aizoaceae	CACH38
Carpobrotus edulis	hottentot fig, freeway iceplant	Aizoaceae	CAED3
Cortaderia jubata	Andean or purple pampas grass, jubata grass	Poaceae	COJU2
Cortaderia selloana	Uruguayan pampas grass	Poaceae	COSE4
Cystisus scoparius	Scotch broom	Fabaceae	CYSC4X
Delairea odorata	cape ivy	Asteraceae	DEOD
Digitalis purpurea	purple foxglove	Scrophulariaceae	DIPU
Dipsacus sativus	indian teasel	Dipsacaceae	DISA9X
Echium candicans	pride of Madeira	Boraginaceae	ECCA5
Ehrharta erecta	panic veldt grass	Poaceae	EHER
Eucalyptus globulus	bluegum eucalyptus	Myrtaceae	EUGL
Foeniculum vulgare	sweet fennel	Apiaceae	FOVU
Genista monspessulana	French broom	Fabaceae	GEMO2X
Hedera helix	English ivy	Araliaceae	HEHE
Ilex aquifolium	English holly	Aquifoliaceae	ILAQ80
Linaria vulgaris	butter and eggs	Scrophulariaceae	LIVU2X
Marrubium vulgare	horehound	Lamiaceae	MAVU
Melilotus alba	white sweetclover	Fabaceae	MEAL2X
Meliotus indica	sourclover	Fabaceae	MEIN2X
Oxalis pes-caprae	Bermuda buttercup	Oxalidaceae	OXPE
Paspalum dilatum	dallis grass	Poaceae	PADI3X
Pennisetum clandestinum	Kikuyu grass	Poaceae	PECL2
Phalaris aquatica	Harding grass	Poaceae	PHAQXX
Pittosporum undulatum	Victorian box	Pittosporaceae	PIUN2
Rubus discolor [procerus]	Himalayan blackberry	Rosaceae	RUDI2
Vinca major	periwinkle	Apocynaceae	VIMA
Xanthium spinosum	spiny cockleburr	Asteraceae	XASP2X

Appendix B: List of priority invasive species by park (2008) (continued).

Point Reyes: Priority 3 Species: Point occurrences (if patch size <100m^2)

Scientific Name	Common Name	Family	PLANTS Code
Acacia longifolia	Sydney golden wattle	Fabaceae	ACLOXX
Acacia melanoxylon	blackwood acacia	Fabaceae	ACMEXX
Acacia verticillata	prickly Moses	Fabaceae	ACVE2X
Albizia lophantha	silk tree, cape wattle	Fabaceae	ALLOXX
Anthemis cotula	chamomile, dog fennel	Asteraceae	ANCO2X
Bellardia trixago	bellardia	Scrophulariaceae	BETRXX
Berberis darwinii	Darwin's berberis	Berberidaceae	BEDAXX
Brassica rapa	field mustard	Brassicaceae	BRRAXX
Briza maxima	big quakinggrass	Poaceae	BRMAXX
Carduus pycnocephalus	Italian thistle	Asteraceae	CAPY2X
Carduus tenuiflorus	slender-flowered thisle	Asteraceae	CATE2X
Cichorium intybus	chicory	Asteraceae	CIINXX
Cirsium vulgare	bull thistle	Asteraceae	CIVUXX
Conium maculatum	poison hemlock	Apiaceae	COMA2X
Crataegus monogyna	singleseed hawthorn	Rosaceae	CRMOXX
Datura stramonium	jimsonweed, thorn apple	Solanaceae	DASTXX
Dipsacus fullonum	common or Fuller's teasel	Dipsacaceae	DIFU2X
Drosanthemum floribundum	showy dewflower	Aizoaceae	DRFL2X
Echium plantagineum	salvation jane	Boraginaceae	ECPLXX
Erechtites glomerata	Australian fireweed, cutleaf burnweed	Asteraceae	ERGL8X
Erechtites minima	Australian fireweed, coastal burnweed	Asteraceae	ERMI6X
Hirschfeldia incana	shortpod mustard	Brassicaceae	HIIN3X
Holcus lanatus	velvet grass, Yorkshire fog	Poaceae	HOLAXX
Hypericum calycinum	Aaron's beard	Clusiaceae	HYCA10
Hypochaeris glabra	smooth catsear	Asteraceae	HYGL2X
Leontodon taraxacoides ssp.longirostris	lesser hawkbit	Asteraceae	LETALX
Lepidium strictum	upright pepperweed	Brassicaceae	LEST2X
Lythrum hyssopifolia	hyssop loosestrife	Lythraceae	LYHY2X
Mentha pulegium	pennyroyal	Lamiaceae	MEPUXX
Myoporum laetum	myoporum	Myoporaceae	*MYLA5X*
Pinus radiata	Monterey pine	Pinaceae	PIRA2X
Populus alba	white poplar	Salicaceae	POAL7X
Pyracantha angustifolia	narrowleaf firethorn	Rosaceae	PYANXX
Rosa eglanteria	sweetbriar rose	Rosaceae	ROEGXX
Rumex acetosella	sheep sorrel	Polygonaceae	RUAC3X
Scabiosa atropurpurea	mourningbride	Dipsacaceae	SCATXX
Silybum marianum	blessed milkthistle	Asteraceae	SIMA3X
Sorghum halepense	Johnson grass	Poaceae	SOHAXX
Tanacetum parthenium	feverfew	Asteraceae	TAPA6X
Verbascum blattaria	moth mullein	Scrophulariaceae	VEBLXX
Watsonia meriana	bulbil bugle-lily	Iridaceae	WAMEXX
Zantedeschia aethiopica	calla lily	Araceae	ZAAEXX

Appendix B: List of priority invasive species by park (2008) (continued).

Point Reyes: Priority 3.1 Species: Point occurrences and polygon assessments

Scientific Name	Common Name	Family	PLANTS Code
Acroptilon [Centaurea] repens	Russian knapweed	Asteraceae	ACRE3X
Aegilops triuncialis	barbed goatgrass	Poaceae	AETRXX
Anthoxanthum odoratum	sweet vernalgrass	Poaceae	ANODXX
Brachypodium distachyon	purple false brome	Poaceae	BRDI2
Dittrichia graveolens	stinkweed	Asteraceae	DIGR4X
Ehrharta calycina	perennial veldt grass	Poaceae	EHCAXX
Festuca arundinacea	tall fescue	Poaceae	FEAR3X
Salsola soda	oppositeleaf Russian thistle	Chenopodiaceae	SASO3X

Point Reyes: Priority 4: Presence/absence (advanced observers)

Scientific Name	Common Name	Family	PLANTS Code
Agrostis avenacea	Pacific bentgrass	Poaceae	AGAVXX
Agrostis capillaris	colonial bentgrass	Poaceae	AGCA5X
Agrostis stolonifera	creeping bentgrass	Poaceae	AGST2X
Agrostis viridis	green bent	Poaceae	AGVI11
Allium triquetrum	threecorner leek	Liliaceae	ALTR4X
Avena barbata	slender oat	Poaceae	AVBAXX
Avena fatua	wild oat	Poaceae	AVFAXX
Brassica nigra	black mustard	Brassicaceae	BRNIXX
Briza minor	little quakinggrass	Poaceae	BRMI2X
Bromus diandrus	ripgut brome	Poaceae	BRCA6X
Bromus hordeaceus	soft brome	Poaceae	BRHO2X
Bromus madritensis ssp. rubens	red brome	Poaceae	BRMARX
Convolvulus arvensis	field bindweed	Convolvulaceae	COAR4X
Crocosmia X crocosmiiflora	crocosmia, montbretia	Iridaceae	*CRCR6X*
Cynosurus echinatus	bristly dogstail grass, hedgehog dogtail	Poaceae	CYECXX
Dactylis glomerata	orchard grass, cocksfoot	Poaceae	DAGLXX
Euphorbia lathyris	gopher plant, caper spurge	Euphorbiaceae	EULA4X
Geranium dissectum	cutleaf geranium	Geraniaceae	GEDIXX
Hordeum marinum ssp. gussonianum	Mediterannean barley	Poaceae	HOMAGX
Hordeum murinum	mouse barley	Poaceae	HOMUXX
Hypochaeris radicata	hairy cat's ear, false dandelion	Asteraceae	HYRA3X
Leucanthemum maximum	Shasta daisy and hybrids	Asteraceae	LEMA8X
Leucanthemum vulgare	ox-eye daisy	Asteraceae	LEVUXX
Lolium multiflorum	Italian or annual ryegrass	Poaceae	LOMUXX
Lolium perenne	Italian or perennial ryegrass	Poaceae	LOPEXX
Lotus corniculatus	Birdsfoot trefoil	Fabaceae	LOCO6X
Medicago polymorpha	California burclover	Fabaceae	MEPO3X
Picris echioides	bristly oxtongue	Asteraceae	PIECXX

Appendix B: List of priority invasive species by park (2008) (continued).

Point Reyes: Priority 4: Presence/absence (advanced observers) (continued).

Scientific Name	Common Name	Family	PLANTS Code
Plantago lanceolata	English or lanceleaf plantain, ribgrass	Plantaginaceae	PLLAXX
Poa pratensis ssp. pratensis	Kentucky bluegrass	Poaceae	POPRP2
Polypogon monspeliensis	rabbitfoot beardgrass	Poaceae	POMO5X
Raphanus raphanistrum	wild radish	Brassicaceae	RARA2X
Raphanus sativus	wild radish	Brassicaceae	RASA2X
Romulea rosea var. australis	rosy sandcrocus	Iridaceae	ROROAX
Rumex crispus	curly dock	Polygonaceae	RUCRXX
Silene gallica	windmill catchfly	Caryophyllaceae	SIGAXX
Sonchus arvensis	perennial sowthistle	Asteraceae	*SOAR2X*
Trifolium hirtum	rose clover	Fabaceae	TRHI4X

Point Reyes: Priority 5.1 Species (Aquatic plants): Point occurrences and polygon assessments

Scientific Name	Common Name	Family	PLANTS Code
Alisma lanceolatum	lanceleaf water plantain	Alismataceae	ALLA2X
Arundo donax	giant reed	Poaceae	ARDO4X
Conicosia pugioniformis	narrow-leaved iceplant	Aizoaceae	COPU18
Egeria densa	Brazilian elodea or waterweed	Hydrocharitaceae	EGDEXX
Iris pseudacorus	yellow flag	Iridaceae	IRPSXX
Lepidium latifolium	perennial pepperweed, tall whitetop	Brassicaceae	LELA2X
Myriophyllum aquaticum	parrot's-feather	Haloragaceae	MYAQ2X
Phalaris arundinacea	reed canary grass	Poaceae	PHAR3X
Spartina alterniflora	Atlantic, saltmarsh, or smooth cordgrass	Poaceae	SPALXX

Point Reyes: Priority 5.2 Species (Dune plants): Point occurrences and polygon assessments (if patch size <100m^2)

Scientific Name	Common Name	Family	PLANTS Code
Ammophila arenaria	European beachgrass	Poaceae	AMAR4X
Cakile maritima	European searocket	Brassicaceae	CAMAXX

Appendix B: List of priority invasive species by park (2008) (continued).

Pinnacles: Priority 1 Species: Point occurrences and polygon assessments

Scientific Name	Common Name	Family	PLANTS Code
Acroptilon [Centaurea] repens	Russian knapweed	Asteraceae	ACRE3X
Lepidium latifolium	perennial pepperweed, tall whitetop	Brassicaceae	LELA2X
Melilotus alba	white sweetclover	Fabaceae	MEAL2X
Nicotiana glauca	tree tobacco	Solanaceae	NIGLXX
Rubus discolor [procerus]	Himalayan blackberry	Rosaceae	RUDI2X
Salsola tragus	prickly Russian thistle	Chenopodiaceae	SATR12
Taeniatherum caput-medusae	Medusahead	Poaceae	TACA8X
Verbascum thapsus	woolly mullein	Scrophulariaceae	VETHXX

Pinnacles: Priority 2 Species: Point occurrences and polygon assessments (if patch size <100m^2).

Scientific Name	Common Name	Family	PLANTS Code
Carduus pycnocephalus	Italian thistle	Asteraceae	CAPY2X
Carduus tenuiflorus	slender-flowered thisle	Asteraceae	CATE2X
Conium maculatum	poison hemlock	Apiaceae	COMA2X
Cynodon dactylon	Bermudagrass	Poaceae	CYDAXX
Marrubium vulgare	horehound	Lamiaceae	MAVUXX

Pinnacles: Priority 3 Species: Point occurrences (if patch size <100m^2).

Scientific Name	Common Name	Family	PLANTS Code
Amaranthus albus	tumbleweed	Amaranthaceae	AMALXX
Brassica nigra	black mustard	Brassicaceae	BRNIXX
Brassica rapa	field mustard	Brassicaceae	BRRA
Centaurea melitensis	Napa thistle, tocalote	Asteraceae	CEME2
Centaurea solstitialis	yellow starthistle	Asteraceae	CESO3
Cirsium vulgare	bull thistle	Asteraceae	CIVU
Hirschfeldia incana	shortpod mustard	Brassicaceae	HIIN3
Lactuca serriola	prickly lettuce	Asteraceae	LASE
Mentha spicata var. spicata	spearmint	Lamiaceae	MESP3
Mentha X piperita	peppermint	Lamiaceae	MEPI
Plantago lanceolata	English or lanceleaf plantain, ribgrass	Plantaginaceae	PLLA
Polygonum arenastrum	oval-leaf knotweed	Polygonaceae	POAR11
Raphanus sativus	wild radish	Brassicaceae	RASA2
Rumex acetosella	sheep sorrel	Polygonaceae	RUAC3
Rumex crispus	curly dock	Polygonaceae	RUCR
Silybum marianum	blessed milkthistle	Asteraceae	SIMA3

Appendix B: List of priority invasive species by park (2008) (continued).

Pinnacles: Priority 3.1 Species: Point occurrences and polygon assessments.

Scientific Name	Common Name	Family	PLANTS Code
Ailanthus altissima	tree-of-heaven	Simaroubaceae	AIAL
Chenopodium ambrosioides	Mexican-tea	Chenopodiaceae	CHAM
Dittrichia graveolens	stinkweed	Asteraceae	DIGR
Lolium multiflorum	Italian or annual ryegrass	Poaceae	LOMU
Lolium perenne	Italian or perennial ryegrass	Poaceae	LOPE
Lolium temulentum	darnel	Poaceae	LOTE2
Malva parviflora	cheeseweed	Malvaceae	MAPA5
Picris echioides	bristly oxtongue	Asteraceae	PIEC
Piptatherum miliaceum	smilo grass	Poaceae	PIMI3
Poa bulbosa	bulbous bluegrass	Poaceae	POBU
Tragopogon dubius	yellow salsify, goat's beard, oyster plant	Asteraceae	TRDU
Tribulus terrestris	puncturevine	Zygophyllaceae	TRTE
Trifolium hirtum	rose clover	Fabaceae	TRHI4
Verbascum blattaria	moth mullein	Scrophulariaceae	VEBL
Xanthium spinosum	spiny cockleburr	Asteraceae	XASP2

Pinnacles: Priority 4 Species: Presence/absence (advanced observers)

Scientific Name	Common Name	Family	PLANTS Code
Amaranthus retroflexus	redroot amaranth	Amaranthaceae	AMRE
Anthemis cotula	chamomile, dog fennel	Asteraceae	ANCO2
Artemisia biennis	biennial wormwood	Asteraceae	ARBI2
Avena barbata	slender oat	Poaceae	AVBA
Avena fatua	wild oat	Poaceae	AVFA
Bromus arenarius	Australian brome	Poaceae	BRAR3
Bromus diandrus	ripgut brome	Poaceae	BRDI3
Bromus hordeaceus	soft brome	Poaceae	BRHO2
Bromus madritensis ssp. rubens	red brome	Poaceae	BRMAR
Bromus trinii	Chilean chess	Poaceae	BRTR2
Capsella bursa-pastoris	shepherd's-purse	Brassicaceae	CABU2
Chamaesyce maculata	spotted spurge	Euphorbiaceae	CHMA15
Chamomilla suaveolens	pineappleweed	Asteraceae	CHSU5
Chenopodium album	lambsquarters, goosefoot	Chenopodiaceae	CHAL7
Cynosurus echinatus	bristly dogstail grass, hedgehog dogtail	Poaceae	CYEC
Erodium botrys	longbeak stork's bill	Geraniaceae	ERBO
Erodium brachycarpum	shortfruit stork's bill	Geraniaceae	ERBR14
Erodium cicutarium	redstem filaree	Geraniaceae	ERCI6
Erodium moschatum	musky stork's bill	Geraniaceae	ERMO7
Filago [Logfia] gallica	narrowleaf cottonrose	Asteraceae	FIGA
Gastridium ventricosum	nit grass	Poaceae	GAVE3
Geranium dissectum	cutleaf geranium	Geraniaceae	GEDI

Appendix B: List of priority invasive species by park (2008) (continued).

Pinnacles: Priority 4 Species: Presence/absence (advanced observers) (continued).

Scientific Name	Common Name	Family	PLANTS Code
Gnaphalium luteoalbum	Jersey cudweed	Asteraceae	GNLU
Herniaria hirsuta ssp. cinerea	hairy rupturewort	Caryophyllaceae	HEHIC
Hypochaeris glabra	smooth catsear	Asteraceae	HYGL2
Hypochaeris radicata	hairy cat's ear, false dandelion	Asteraceae	HYRA3
Lythrum hyssopifolia	hyssop loosestrife	Lythraceae	LYHY2
Medicago polymorpha	California burclover	Fabaceae	MEPO3
Melilotus indica	sourclover	Fabaceae	MEIN2
Nicotiana acuminata var. multiflora	manyflower tobacco	Solanaceae	NIACM
Plantago major	broadleaf or common plantain	Plantaginaceae	PLMA2
Polycarpon tetraphyllum	fourleaf manyseed	Caryophyllaceae	POTE
Polypogon interruptus	ditch rabbit's-foot grass	Poaceae	POIN7
Polypogon monspeliensis	rabbitfoot beardgrass	Poaceae	POMO5
Portulaca oleracea	purslane	Portulacaceae	POOL
Silene gallica	windmill catchfly	Caryophyllaceae	SIGA
Sisymbrium orientale	oriental hedgemustard	Brassicaceae	SIOR4
Spergula arvensis ssp. arvensis	corn spurry	Caryophyllaceae	SPAR

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